THURSDAY, JULY 23, 1885

## A NEW DEPARTURE FOR THE UNIVERSITY OF LONDON

THE influential movement which has grown out of the Educational Congress held during the Health Exhibition last year at South Kensington, and which has for its object the establishment of a Teaching University for London, has placed the existing University on the horns of a dilemma. Either it must be content to see itself altogether outdistanced by a new organisation which of necessity would absorb into itself all the teaching eminence of London, or it must rise to the occasion, and, bursting the cramped limits of its present contracted sphere of activity, show itself competent to the performance of larger duties.

The Convocation of the University, composed of the general body of graduates, has for its part shown at any rate a disposition to choose the latter alternative. After two successive debates it appointed a committee of forty of its members to see how far the proposals of the Association for a Teaching University could be carried into effect by the existing University. The report of the Committee has now been issued, and was printed by us in last week's NATURE. It will be submitted to an extraordinary meeting of Convocation to be held on Tuesday next.

What the action of the graduates will be it is of course impossible to predict with certainty. But it is hardly conceivable that, having assented to the principle of developing the University in the direction proposed by the Association, they will find much difficulty in accepting the scheme of reorganisation presented to them by Lord Justice Fry.

The scheme itself is necessarily cast in a somewhat technical form, and it is unaccompanied by any memorandum explanatory of its leading principles. These, however, it is not difficult to glean from it, and some account of them will, we think, be not without interest to many of our readers.

*A priori* the name of the University of London would call up to the mind of any one unfamiliar with the reality the image of a very splendid institution. This enormous city, which sooner or later absorbs into its life everything and everybody that rivets attention in the mind of the nation at large, might be expected to possess in its university a seat of learning where all the best of its intellectual activity would, as it were, be brought to a focus. That is the ideal. The reality is quite different. It is, in fact, a Government office which only by a kind of grim jest bears the name of a university. It is true it gives degrees; its graduates array themselves in gowns of surpassing brilliancy; it has a library and portraits of vice-chancellors; it has even a member of Parliament, But these are the mere accidents of its nature. Pierce below these insignificant academic symbols, and you find nothing but a mere State examination board supported by a Parliamentary grant; its expenditure controlled by the Treasury; its accounts audited by the Audit Office; and every academic regulation requiring the approval of the Home Secretary. Of any provision for the advancement and cultivation of knowledge there is none.

London however abounds with institutions of more or less eminence, in which studies of an academic kind are pursued. The first step which the Association saw to be necessary was to endeavour in some way to federate these. The task is one of no small difficulty. No educational establishment of any standing would care to sacrifice any portion of its autonomy, or to see taken from it any possible field of activity to which it might legitimately aspire. On the other hand, universal experience has shown that it is only those who are actually engaged in the higher kind of teaching who can be counted upon to supply the propulsive force needed for a real University activity. It is only those who work in the ultimate allotments of the fields of learning who can say how the achieved results in each area can be adapted to educational needs, and what help a University can give in securing harvests still ungrown and unreaped.

The leading feature of the scheme is—frankly following the principle on which the examining staff is secured—to bring into the University, irrespective of their previous connection with it, the best of the London teachers of University rank. These are to be obtained as representatives of Colleges who have agreed to come into the scheme. What these bodies sacrifice by so doing is scarcely appreciable. What they may gain may be very considerable. The teaching representatives so obtained (with some additional members) are to be grouped into four Faculties. In these Faculties the teaching arrangements of the several constituent Colleges may, though not necessarily, be brought into discussion. The result, it may be hoped, will be a better division by amicable arrangement of the higher educational appliances of the metropolis. And where (with the approval of the faculty) any particular constituent College undertakes the charge of some slenderly-supported branch of learning, it can hardly be doubted that the approval of the faculty will at least go a long way to securing public interest in the venture.

The faculties, then, can hardly fail to promote cooperation among the University teachers in London, and to better organise the attack on ignorance. But besides this they will enable the teaching bodies to gain for the first time a direct influence upon the examinations. Each Faculty will appoint a Board of Studies, and this will be charged with the duty of watching the examinations, keeping up something like a continuous tradition, and seeing that examination and teaching are in reasonable adjustment. Furthermore the Faculties will have direct representation on the Senate and that august body will in time be no longer a mere assemblage of notables holding their seats for life, but a real Academic Council for London at large, the members of which, being removable after a term of years, will always be in touch with their constituents.

These are the main outlines of the scheme. They appear to us to have been dexterously drawn between interference which the Colleges would resent and responsibility for their administration which the University could not accept. But though all this is admirable, it would not satisfy us if it were to be regarded as the final outcome of the scheme. Its great merit in our eyes is the

provision we see in it for continuous development. The Faculties, the Boards of Studies, the Senate, are all under the scheme subject to provisions for renewing their composition. There will be therefore, we hope, a properly controlled flow of new life through every branch of the governing authority of the University. The present condition of crystalline rigidity will dissolve. As new objects of University enterprise come to the surface and assume definite shape, the men who advocate them will find their way to the Faculties and succeed in making their voices heard. At the same time there is sufficient opportunity for discussion to prevent the University being launched unadvisedly in any rash development.

We do not conceal our own hope that the most important outcome of the new scheme will be the ultimate provision of appliances for the prosecution of the higher studies in London. These never can be self-supporting, and never can, therefore, be properly undertaken by the constituent colleges. Ths voice of the faculties must be in the long run the voice of the men who compose them. That they will, therefore, if constituted, take some action in the matter, can scarcely be doubted. But instead of individual voices crying in the wilderness, there will be the mature utterances of a responsible body carefully guarding the interests of the constituent colleges on the one hand, and looking to the distinction and influence of the University on the other. Properly considered schemes will be put forward, and whether their execution devolves on the State, or is undertaken by private munificence, the public will for the first time have in the Faculties an authority competent to advise it in such matters, and whom it can listen to with confidence. The ultimate expansion of the University into all that can be desired, appears to us the inevitable outcome of Lord Justice Fry's scheme, if it is carried into effect.

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## THE WOOL FIBRE

*The Structure of the Wool Fibre in its Relation to the Use of Wool for Technical Purposes.* By F. H. Bowman, D.Sc., F.R.S.E., F.L.S., &c. (Manchester: Palmer and Howe; London: Simpkin Marshall and Co., 1885.)

THIS is a series of lectures delivered by Dr. Bowman to the students of the Bradford Technical College and the members of the Dyers' and Colourists' Society, and is in continuation of a similar series on the "Cotton Fibre."

The subject is one of so great importance that Dr. Bowman is amply justified in concluding that the information contained in his lectures ought to be accessible to others than students; for, if there is anything to learn with respect to a great national industry like the woollen trade, it is highly desirable that no time should be lost in communicating it to those who are now engaged in the trade, rather than that we should wait half a generation for the knowledge to become available in the hands of the students.

It is no doubt very difficult to introduce new methods and to banish old ones, except by the introduction of young blood; but even so, something may be done in the way of preparing the minds of the older workers to receive the new ideas of the young ones, and this at least Dr. Bowman's work is likely to do.

Whether Dr. Bowman has been wise in preserving the lectures in their original form in his book we take leave to doubt. It makes the book very much larger than it would otherwise have been, owing to the unnecessary recapitulation at the commencement of each lecture, and not only so, but the labour and attention which would have been required to remodel the lectures would have prevented some glaring errors and defects of style which are by no means creditable to a writer of Dr. Bowman's attainments. A careful perusal of the proof-sheets would surely have removed such errors as "the appearance of the bulbous parts are very similar;" "the Exmoor sheep are the smallest of the two;" and the vulgarism, "some of the sheep in the northern districts have four and even six horns, *the same as* the Iceland sheep."

These literary defects notwithstanding, the book is most opportune and valuable. The key-note of the whole is perhaps to be found in the following sentence:—"All our machines and processes are only a means to an end, and the correct method of proceeding is ever to have the end in view from the beginning. Strange as this may appear, such is not always the case in our manufactures, and especially in those where the materials pass through many hands in different works before reaching the final stage. How often do we find the farmer, for example, quite careless in regard to the nature of the dips, and washes, and smears which he uses for his sheep, in utter forgetfulness of the fact that, although he may gain a temporary advantage, he is spoiling the wool for future use in spinning and dyeing."

Dr. Bowman puts forcibly before his readers the fact that wool is a part of the skin of the animal on which it grows, and is capable of being modified to a very great extent indeed—much more than most people are aware—by change of climate, food, and other surroundings, and especially by judicious breeding. One-sixth of the book is devoted to an enumeration of the various breeds of sheep to be found in the world, for the purpose of illustrating this. Perhaps, if we may be permitted to say so, this division of the work might have been judiciously shortened by the omission of details respecting numerous breeds of sheep which are now of little more than historical importance, especially as Dr. Bowman appears to be of opinion that the course which has been followed is the right one, and that we are now in possession of practically the best breeds of sheep which we could have for wool-producing purposes.

The lectures are five in number, of which the first is chiefly introductory. In it the author discusses the difference in composition and structure of animal and vegetable fibres and minutely describes the structure of cotton, silk, and wool as disclosed by the microscope. He points out the distinction between hair and wool so far as any real difference exists, and describes the constitution of the skin and the mode of production and growth of hair or wool.

The second lecture is chiefly devoted to a description of the various breeds of sheep and of the results of cross-breeding.

In the third lecture the author describes the typical structure of wool fibre under the two heads: (*a*) in regard

to the mechanical arrangement of its ultimate parts; (*b*) in regard to its chemical composition.

The fourth and fifth lectures deal with, first, the variations from the typical structure found in fibres taken from the same animal and grown at the same time, in fibres from the same animal grown in different years, in fibres from the same animal grown under different climatic and other conditions, and in fibres from different breeds of sheep grown in different countries; and, secondly, the effect of these variations in the manufacturing processes.

There are a number of excellent illustrations which materially assist the reader.

It has hitherto been too commonly supposed that the sheep might be turned out upon our bleak and barren hillsides, of which no other use could be made, and left to its own resources; but this is doubtful economy, even as regards the land, and Dr. Bowman shows that as to the sheep it simply ruins the wool. "The wool and its character depend very largely not only on the health of the sheep, but also upon climatic and other influences. The mildness or severity of the season and the plenty or scarcity of food very largely affect the character of the wool. In very severe seasons there is a tendency to a thickening of the fibres, with greater irregularity in the length of the general staple and a greater rankness of the fleece, with undergrowth of short fibres and a greater irregularity in the diameters of the individual fibres and the different parts of the same fibre. The general character of the wool is also affected because from constant wetting and drying in the bad seasons the wool becomes tender and rotten and loses its brilliancy and lustre." "When examined under the microscope the individual fibres are found to be injured in their structure by the want of proper nourishment and the deficiency in the natural suint or grease, a great part of which is soluble in water, and when removed leaves the fibres dry and hask. Of course amongst well tended flocks these variations are reduced to a minimum, because they are supplied with suitable shelters from the storms and fed artificially when there is a scarcity of pasture." Most farmers think more of the mutton than of the wool, but whatever improves the one improves the other, and it would pay them well to devote more attention to the comforts of our hillside sheep, and even of those which are pastured in more favourable situations.

Great improvements have, we believe, been effected in apparatus for washing wool, but perhaps Dr. Bowman is right in saying that even yet sufficient attention is not paid to the temperature of the water. It seems to be forgotten that wool is an animal matter and that "the real base of the wool fibre is a body which very closely resembles, and is allied to, the albumenoids, and all these bodies are subject to very great changes in molecular condition when subjected even to moderate degrees of heat." Dr. Bowman made a number of experiments with "a bright-haired wool" to determine the effect on its lustre and strength of washing at different temperatures in pure water. He found that "wool which looked quite bright when well washed with tepid water was decidedly duller when kept for some time in water at a temperature of 160° F.; and the same wool, when subjected to boiling water 212° F., became quite dull and lustreless." As Dr Bowman elsewhere says, when water is heated by blowing in jets of steam, as is not unusual in wool-washing, the temperature varies in different parts, being nearly or quite 212° close to the steam jet, whilst very much lower at a little distance.

W. H. S. W.

## *PHYSIOLOGY OF THE EMBRYO*

*Specielle Physiologie des Embryo. Untersuchungen über die Lebenserscheinungen vor der Geburt.* Von W. Preyer. (Leipzig: Th. Grieben's Verlag, 1885.)

THE vital processes of the embryo present so many difficulties in their investigation that, in spite of their great interest, they have hitherto received only a small share of the physiologist's attention. Prof. Preyer's new book will therefore be received with welcome as an important contribution to our knowledge of the subject; and is likely, on account of its completeness, to become a standard text-book.

The work is an almost exhaustive summary (extending to more than 600 pp. 8vo) of the results of investigations into this branch of physiology from the time of Aristotle downwards. Indeed, so large a proportion of other men's researches are included, that the title "Untersuchungen . . . von W. Preyer" would seem to require modification.

The reader may be a little disappointed with the earlier portion of the book, on account of the trite nature of some subjects which could hardly have been omitted; but the matter increases in interest with the progress of the work, and especially where the author's own researches are described. The style is not as condensed as could be wished: but this fault is not uncommon in scientific writings.

Although the common chick most rightly receives a large share of attention, yet other animals—mammalia, reptiles, and fishes—are not in any way neglected, and even invertebrates are occasionally touched upon. The most valuable observations are those on the guinea-pig, dog, &c. The author laments the scarcity of material and of opportunities for observation on the human subject; and recommends that in foundling hospitals and lying-in institutions a supply of apparatus should be kept ready for observing the physiology and pathology of the new-born; since much may be learnt from the phenomena, especially the changes, which occur within the first minutes or hours after birth.

In the first section, which treats of the embryonic circulation, Prof. Preyer shows the probability that in the chick the primitive blood, or hæmolymph, begins to move before the occurrence of the first heart-beat. This he attributes to the effect of heat, the heart occupying a higher position in the embryo than the vessels, so that by convection the blood tends to rise towards the heart and distend it. This explanation is not satisfactory on physical grounds: for it is difficult to realise that there can be a difference of temperature between the contents of a minute vessel and its surroundings sufficient to cause such a movement. Is it not equally probable that the change of specific gravity may be due to chemical changes in the hæmolymph; or, more probable than either, that the fluid is formed in the peripheral vessels and driven onwards by the pressure of osmosis?

Among the most important results of experiments are those connected with the effect of temperature and of chemical agents on the embryo; especially the very potent action of quinine and atropine on the primitive heart; and the comparative inertness of strychnia, curarin, and hydrocyanic acid on the more advanced fœtus. These results, considered with those relating to the diffusion of substances between mother and fœtus, have a practical bearing on the medical use of the various drugs during pregnancy. No less important therapeutically are the effects of change of blood-pressure in the uterine vessels; and a very practical though old question is fully discussed—namely, whether the umbilical cord should be divided early or late after delivery.

In certain experiments the coagulation of blood from the embryo was observed to be very slow. It would be interesting if it were shown that coagulability is acquired only shortly before the birth of the animal, when it first needs this property of the blood to guard it against hæmorrhage.

The most interesting section of the book is that which deals with the secretions of the embryo. The experiments of the author and other observers are collated, with the result of showing the early appearance and activity of some of the digestive fluids, and the comparatively late acquirement of the amylolytic faculty, particularly in the human species. The origin of the amniotic fluid is here discussed—how far it is derived from the maternal or from the fœtal blood, and whether and to what extent the fœtal urine contributes to its formation.

Prof. Preyer endeavours to find a satisfactory derivation for the word *amnion*. It does not appear to him possible to connect it with ἀμνίον, a receptacle for the blood of a victim in a sacrifice, with ἀμνός, a lamb, or other proposed sources; so he suggests an origin from α-, and μένος, strength, because of the delicacy and lacerability of this membrane. This may be physiological, but it is hardly philological. If we cannot be satisfied with the explanation that ἀμνίον in either sense was something which appertained to a lamb, we may conjecture an earlier origin from the root *am-*, around, seen in ἀμ-φί, *amputare*, and German *um;* in which case ἀμνίον may mean a receptacle or envelope.

There is no doubt that spontaneous movements of the embryo take place long before its maturity, and Prof. Preyer considers that muscular action occurs earlier than is generally supposed. He adduces the fact that the umbilical cord has already begun to twist in the human embryo at the eighth week, and asks, "How else could this take place, if not through the fœtal movements?" Now it seems improbable that the muscular movements should be entirely or even mostly in one direction; and therefore some more satisfactory explanation must be sought. We would suggest that the twisting may be due to the excessive growth of the umbilical arteries, so that they are obliged to take a tortuous course: and, when a slight obliquity has once been established, every pulsation will tend to increase the spiral, and every movement of the fœtus or of the mother will be taken advantage of; the cord and fœtus revolving together until, with the growth of the fœtus, the friction of the amnion puts an end to the rotation.

The section dealing with the senses of the embryo is scarcely less interesting than that on the secretions. In connection with this we find a discussion on the state of the nervous system before maturity: whether it be in a waking or a sleeping condition, or whether these conditions alternate with one another.

Among the appendices is one, by Dr. R. Ziegenspeck, of Jena, treating of the fœtal circulation. There are also several coloured plates illustrating the circulation and other subjects. The usefulness of the book is much enhanced by the addition of a list of the literature on the special physiology of the embryo. The books and papers in this list (552 in all) are numbered and indexed; and, whenever either of them is quoted in the text, its corresponding number is given in the margin for reference.

F. J. Allen

## OUR BOOK SHELF

*The Animal Parasites of the Sugar Cane.* By H. Ling Roth, late Hon. Sec. to the Mackay Planters' Association. Reprinted from *Sugar Cane*, March and April, 1885. (London: Trübner.)

It is within the knowledge of most people that when a matter of this kind is under consideration, there are never wanting those who are ready with suggestions—for the most part based upon a foundation anything but practical or logical. Quacks are always at hand with their "cures," greedy for the gain which it is the object of their impositions to intercept. Experience and common sense alike show that but two courses here lie open: either the cane-crop must be rooted up and something else substituted in its place, or the most searching inquiries must be instituted into the life-histories and conditions of existence of the organisms working the mischief.

The value of any publication on such a subject must, from the above considerations, be proportionate to the extent to which it assists the farmer in dealing experimentally with his enemies. Looked at from this standpoint, Mr. Roth's modest little pamphlet cannot fail to be of great service to the intelligent planter, for it embodies, together with the results of the author's practical experience, a bibliography of all that has been written on the subject.

Planters are beyond doubt largely a conservative body, and it is well known that years ago when first the failures of the Ceylon coffee-crops became disastrous, the attention of the grower was in vain directed to the tea-plant—then flourishing as an ornamental shrub in the gardens of certain residents. The deaf ear has since been opened, and the mourning of the disappointed coffee-grower is now being turned into the joy of the successful tea-planter. Unfortunately the conditions of growth of the sugar-cane will not admit of so easy a solution of the problem as that available in the above cited case, but the refrain of the paper before us is *more biology.* Nothing whatever can be done until the world is fully familiarised with the life-cycles and conditions necessary for the existence of the said parasites. The success which has recently attended the study of the liver-rot among sheep may be instanced as an example of what can be done in the field of applied biology, and there are among us young and competent workers ready to take the task in hand should opportunity offer.

The facts narrated on p. 2 of the paper are anything but encouraging to those who would seek Government aid. Much can be done by Governments, and it may be that when corporate bodies realise that pests of the category of those now occupying our notice are formidable even as an armed force, they will see fit to turn attention to them.

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

### Nomenclature in Elasticity

IN reference to a communication of mine which you published not long ago (see NATURE, vol. xxxi. p. 504) on this subject, I have pleasure in enclosing for publication, should you think fit, photos from three automatically recorded stress-and-strain diagrams made in my laboratory. The originals were traced on smoked glass, the glass plate then varnished to fix it, and used at once as a negative. Test-piece No. 9461, of which Fig. 1 shows the behaviour, was a very ductile piece of Swedish bar-iron, turned to ¾-inch diameter. The extensions were measured on a length of 10 inches, and recorded *double* full size; they are to be measured from the curved base-line, distances along which measure the total load on the piece (on a scale, as recorded, of about 1·9 tons per inch), and therefore the load per unit area (or, as I prefer to call it, the *intensity of stress*) up to the limit of elasticity, to which point the cross-section remains practically unchanged. The point where *instability* comes in is very marked, and also the release or going back of the stress after the material has "broken down." Lastly, the condition of local flow, or whatever it is to be called, is excellently shown. The material draws down in one place, so that the increase of extension, being confined to that place, is very small, and the total load diminishes, although the intensity of stress, on the now greatly reduced area, is much increased, as is shown further on in Fig. 4.


FIG. 1.

Fig. 2 is an autographic diagram similar to the last, taken from a piece of soft steel (No. 8397) 0·60 inch diameter and 10 inches long. It shows most of the same characteristics, except that the breaking down is not preceded by any intermediate stage; the loss of elasticity comes very suddenly. The whole load was taken off the piece and then reapplied a number of times during the experiment, after the limit was passed, and the curves show most distinctly by their parallelism the (practical) constancy of the modulus of elasticity even up to the very maximum load. The curves show also the curious phenomenon —which I have often noticed in this form, and which, in some of its aspects, has been most carefully examined by Bauschinger and others—of increase of load borne, for a very limited time, after the material has been allowed a short rest—here only a few seconds. If the rest be for hours or days a similar thing occurs in a much more marked fashion.

Fig. 3 is a similar diagram from a piece of "S. C. Crown" iron, showing the same features, although in a less marked degree. In this case the load was removed and reapplied after the piece had begun to draw down visibly, and the curve to turn back, with the result of showing the piece to be still elastic up to the load it had just borne.

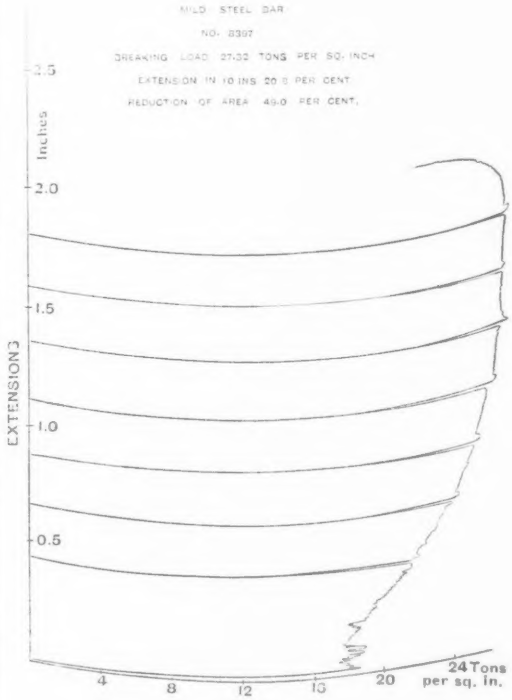



FIG. 2.

Fig. 4, which is a copy of a diagram obtained by consecutive measurements, not automatically, illustrates a question asked, I think, by Mr. Ibbetson. The diameter of the bar under test was measured each time the extension was noted, and the curve of actual stress on actual area (II.) is plotted out, as well as the usual load and strain curve (I.). The most interesting point about it is perhaps the way in which the curve ends nearly parallel to the axis, an excessively small additional extension corresponding to a very great additional intensity of stress. This arises, of course, from the fact that the extension is here confined to a very small length of the bar, the diameter and length of the main part of the bar remaining practically unaltered. If the extensions were plotted to stresses in this main part of the bar, the curve would take the shape (III.).

All these curves illustrate distinctly, I think, a point not very generally known, that the non-elastic extensions form really a

curve passing through the zero point of stress and strain, just as do the elastic ones. It appears as if the ***non-elastic***, the flowing or plastic state, were the ***real*** state of the material, the ***elastic*** condition being something consequent on the treatment which

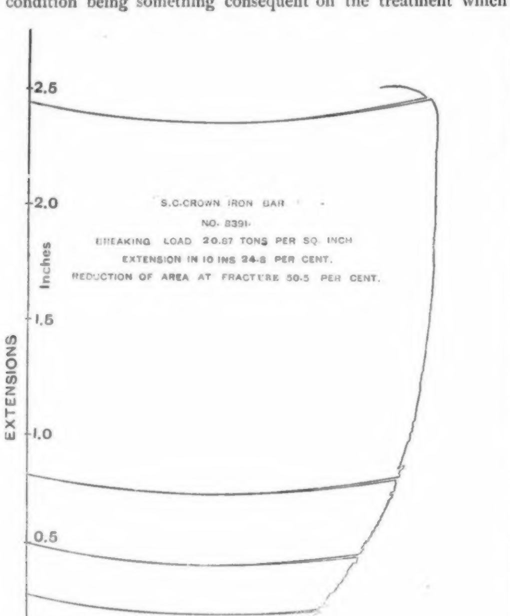



FIG. 3.

the material had undergone. I am bound to say, however, that I have no distinct evidence connecting the ratio $\frac{\text{limit of elasticity}}{\text{maximum load}}$ with the amount of previous work done on a material in manufacture.

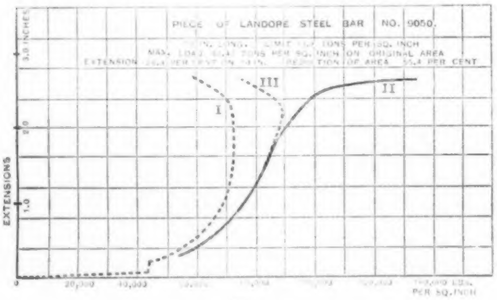


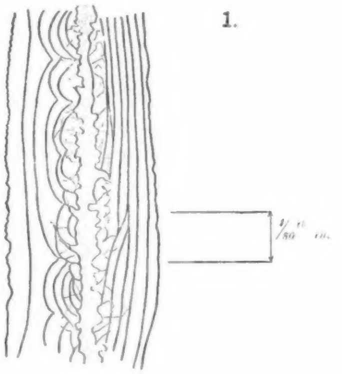

FIG. 4.

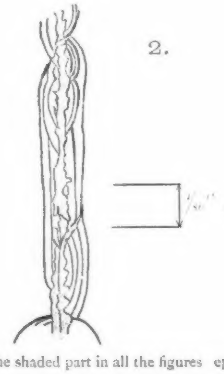
I should like to add that the credit of scheming and working out the very ingenious apparatus by which the autographic diagrams figured above were recorded belongs almost entirely to my friend Mr. A. G. Ashcroft, who has been working at the matter for me for some time. ALEX. B. W. KENNEDY

## Spectra Produced in Glass by Scratching

A FEW weeks ago, while examining under the microscope a piece of glass on which a coarse scratch had been made by a file, in order to serve as a focussing mark in the determination of refractive index, I noticed a number of narrow, somewhat faintly coloured spectra running along both sides of the scratch. As I can find no account of such an appearance, and an examination of it seemed to throw a little light on the effects of a combined tangential stress and pressure on a brittle medium such as glass, I thought a short description of the phenomena might be interesting to the readers of NATURE.

The spectra (Figs. 1 and 2) run for the most part approximately parallel to the scratch, but those near the scratch are very much curved, the concavity being inwards, and often appear to commence and terminate at irregularities in the scratch. If the glass be left to itself after scratching, the spectra sometimes remain stationary, but not unfrequently spread outwards from the scratch; this process I have watched in three instances. In any case, sooner or later, the glass splits internally along the edge of the outermost spectrum, and sometimes along the others also. I was fortunate enough to watch this splitting in one instance: immediately before it took place the glass gave signs of great activity, the spectra waving about in the field of




FIGS. 1 and 2.—The shaded part in all the figures represents the scratch.

view about three times in as many seconds, oscillating between two extreme positions (*a* and *b* in Fig. 3), and finally coming to rest in the position *b*, while the split developed with great rapidity from above downwards in the field of view. After this splitting has taken place, the spreading of the spectra ceases, and they generally, though not invariably, remain apparently unaltered. The time which elapses between the infliction of the scratch and the development of the split varies from a few minutes to several days or weeks.

The appearance is not shown by all scratches, but only by such as have produced considerable disturbance in the glass: thus they must be fairly deep and must produce some slight amount of splintering.

Next, as to the explanation of the phenomenon. Diffraction from the scratch is negatived by the great distance from the scratch to the spectra, and still more by the fact that they are farther apart the greater their distance from the slit; this important point was determined by careful measurement with a micrometer, using sodium light. They are clearly not due to

polarisation, and examination between crossed Nicols failed to elicit any appearance indicating strains in the glass. The spectra seemed to be identical with the colours of thin plates, with which they agree in being much brighter in reflected than in transmitted light. The colours are also complementary in the two cases, as can easily be shown by the use of a micrometer eyepiece; the colour of the band lying on a certain division being noted, the moving of a suitably arranged screen cuts off the light from the mirror under the stage and allows that from a condensing lens above the stage to fall on the glass; the

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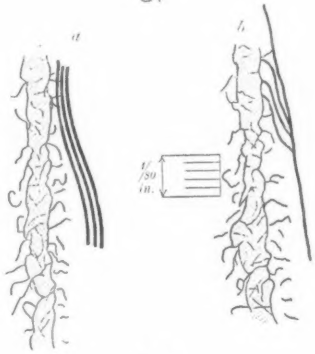


FIG. 3.

colour is then seen to change into its complementary, passing through white if the two lights are of suitable relative brightness. If the surface layers of the glass near the scratch are separated somewhat from those below, the interval forms a thin plate, and this would suffice to account for the spectra, as the separation would necessarily reach a maximum at the scratch, and we there find the spectra nearest together; moreover, along the edge of the outermost spectrum, the black of the first order is quite distinct wherever the spectra are broad enough to allow their colours to be distinguished. The splitting perpendicularly to the cleavage plane would then be quite analogous to that seen in other brittle

4.

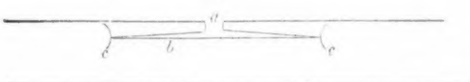


FIG. 4.—*a* = the scratch; *b* = the cleft under the torn-up surface layer; *c c* = the splits.

substances, and as every one must have repeatedly observed it in cutting such substances as camphor, paraffin, or ice (Fig. 4 shows the condition of the glass on this supposition). That a tendency really exists in scratched glass for the surface layers to tear up we know from the fact that splinters of glass near the scratch will often keep peeling off for days together.

E. F. J. LOVE,
Demonstrator of Physics in the Mason College

Birmingham, July 14

### Prof. Sylvester's Article on "A New Example of the Use of the Infinite and Imaginary in the Service of the Finite and Real"

I SHOULD like to be allowed to mention that Mr. Buchheim has drawn my attention to the fact that one of the theorems in the postscript to my recent article in NATURE contained in the formula—

$$P' : Q' = \frac{P : Q}{\sqrt{P : P}\ \sqrt{Q : Q}}$$

is virtually given under a slightly different notation in the second edition of Grassmann's "Ausdehnungslehre," p. 141.

July 12 J. J. SYLVESTER

### Rainfall of N.W. England

THE rainfall on the coast-line of the Dee and the sea from Chester to Llandudno in the spring and summer months presents some interesting features. As a rule the amount of rain is the greatest at the Chester end in the spring months (April to June), and at the Llandudno end in the summer months (July to September). This is shown by the following table:—

| | 1882 | | 1883 | | 1884 | |
|---|---|---|---|---|---|---|
| | Colwyn Bay[1] In. | Chester In. | Colwyn Bay In. | Chester In. | Colwyn Bay In. | Chester In. |
| April | 3·01 | 3·59 | 0·68 | 0·79 | 1·32 | 0·92 |
| May | 1·54 | 2·16 | 1·86 | 1·09 | 1·37 | 0·94 |
| June | 3·39 | 3·95 | 2·15 | 2·94 | 1·15 | 2·06 |
| | 7·94 | 9·70 | 4·69 | 4·82 | 3·84 | 3·92 |
| July | 3·20 | 3·52 | 1·13 | 1·86 | 4·43 | 4·08 |
| Aug. | 3·47 | 2·52 | 2·19 | 2·64 | 1·35 | 1·05 |
| Sept. | 2·45 | 1·80 | 4·34 | 5·07 | 1·67 | 1·95 |
| | 9·12 | 7·84 | 7·66 | 8·57 | 7·45 | 7·08 |

That this result is not a mere coincidence will be gathered from the following statement of the rainfall last month (June, 1885) at Chester, Colwyn Bay, and Bagillt, this last being between the other two places, at a distance of fifteen miles from the former or twenty-five miles from the latter:—

| June | Chester In. | Bagillt In. | Colwyn Bay In. |
|---|---|---|---|
| 5 | 0·12 | 0·07 | 0·18 |
| 6 | ·38 | ·21 | ·20 |
| 7 | ·33 | ·29 | ·24 |
| 8 | ·11 | ·05 | ·01 |
| 16 | ·18 | ·15 | ·03 |
| 18 | ·10 | ·06 | ·05 |
| 19 | ·04 | ·02 | ·02 |
| 20 | ·16 | ·09 | ·03 |
| 23 | ·79 | ·46 | ·32 |
| 24 | ·13 | ·08 | ·02 |
| 29 | — | ·02 | — |
| | 2·34 | 1·50 | 1·10 |

It will be seen that on every day, except one, the rainfall was highest at Chester, Bagillt coming next, and Colwin Bay being the lowest. There must therefore be some definite law which governs this gradual decrease from east to west; and in the hope of drawing out the opinions of more skillful meteorologists on the subject, I venture to suggest the following explanation.

It is generally admitted that atmospheric currents travelling across the Atlantic from the south-west reach our islands charged with aqueous vapour almost to saturation. These, meeting the mountains of Wales and Cumberland, are driven up into a higher and colder region where the moisture is condensed into rain, causing a very heavy rainfall on the *western* slopes. Now if a line be drawn south-west from Colwin Bay, it will be found to pass over some of the highest mountains in Wales, so that *in spring*, when the air above these mountains is still cold, the moisture is so effectually condensed that there is little left to fall on the north-east side. But if a parallel line be drawn south-west from Chester it passes over no very high region, and the moisture is therefore less completely drained from the atmosphere. But, as the summer goes on, the mountain-tops become warmer and the condensation on them less complete, and then more rain is left to fall on the north-east side, *i.e.*, at Colwyn Bay. And as the *summer* day temperature is higher at Chester than Colwyn Bay, less rain is condensed at the former place.

Chester, July 18 ALFRED O. WALKER

### "Foul Water"

MY attention has just been called to Mr. Shrubsole's letter under above title. Having been for several weeks past engaged in dredging off the North Wales coast, I have continuously noticed the profuse amount of gelatinous bodies diffused throughout the sea, evidently of the same character as observed by Mr. Shrubsole off Sheerness. They appeared here early in June.

The little bodies are distinctly visible on holding a bottle of sea-water up to the light. They vary in size from 1/16th to

[1] Colwyn Bay is about five miles east of Llandudno.

1/10th of an inch in diameter, and are spherical or oblong in form, the translucent membrane appearing under the microscope to be composed of minute particles and spicules imbedded therein.

As my observations included the examination of surface-life, the tow-net was continuously employed, and was always rapidly filled with so much gelatinous substance that it was difficult to pick out the Copepoda or other pelagic life. But although all of the bodies were perfect in form when taken in a bottle, the rush of water into the tow-net was sufficient to fracture them, the result being a mass of broken gelatinous *débris* (apparently vegetable) which clung tenaciously to the muslin of the net.

They appeared to be most numerous a few feet below the surface, and are distinctly visible on looking down into the water from the boat-side. Weather does not seem to affect them, being apparently equally prevalent on a calm or a rough day; but I noticed while rowing across from Penmaenmaur to Puffin Island, a distance of seven miles, that they were less plentiful about the middle of the entrance to the Menai Straits than nearer each side.

Early in June they were in profusion about the mouth of the Dee. Associated with them I have invariably found quantities of *Noctiluca*, which soon congregated about the surface of the collecting-jar, while the gelatinous spheres remained suspended in the water, and the *débris* from the tow-net fell to the bottom.

Any light that can be thrown upon the nature and appearance of these curious bodies will be much esteemed.

Liverpool, July 16 ISAAC C. THOMPSON

### The Banner System of Drainage

OUR attention has been called to a paragraph in NATURE (p. 221) in which you review, "Hygiene, a Manual of Personal and Public Health," by A. Newsholme, M.D., Lond. In your review or criticism you state that you "do not agree with Dr. Newsholme in thinking the 'Banner system of drainage one to be recommended,'" and you say your system coincides with that of *several practical sanitarians*. Now, as this is calculated to do harm, and as our system *has* been *approved* of by the *most* eminent sanitarians, and has also obtained the highest awards at all the most important exhibitions, including a Gold Medal at the Health Exhibition, 1884, and has been successfully applied to many noblemen's mansions, hospitals, and other important public buildings, as well as to thousands of houses, we hope you will think we are justified in asking you to tell us your reasons for expressing the unfavourable opinion you have, and that you will oblige us with the names of the "practical sanitarians" you refer to.

We are unacquainted with Dr. Newsholme, and until the paragraph in NATURE was pointed out to us we were not aware of the existence of such a gentleman. Nevertheless, in fairness to him as well as to the public, we will thank you to insert this in your next issue.

BANNER BROTHERS AND CO.,
*per* MANAGER

11, Billiter Square, E.C., July 14

[Exception having been taken by Messrs. Banner & Co. to a statement which appeared in our last issue in the review of the Elementary Text-books of hygiene, having reference to this system, we have no objection to state that (in the opinion of our reviewer) the Banner system, although correct in principle, is unnecessarily complicated in the details of its working. The "Banner Patent Closet" shown in diagram in the book referred to is a modification of the pan-closet, a closet which has been universally condemned and as almost universally acknowledged to be incapable of improvement.—ED.]

## ON THE USE OF CARBON BISULPHIDE IN PRISMS[1]

IN the *American Journal of Science* for April, 1885, there is an account of some experiments of Dr. Draper's which will be read with great interest by all who have used liquid prisms in a spectroscope. The following is an abstract of the article:—

The photographs which were taken in the research on the presence of oxygen in the sun were obtained by the use of two hollow prisms filled with carbon bisulphide. The same prisms had been used by Mr. Rutherford to produce his celebrated solar prismatic spectrum. The photographic work for the oxygen research was done in New York in a back room of the third storey of Dr. Draper's residence. The temperature of the room was remarkably uniform and the definition was all that could be desired. When, however, the research was continued in the new physical laboratory which Dr. Draper completed in 1880, it was found practically impossible to use carbon bisulphide prisms in the room owing to the rapid variations of temperature. No definition whatever could be obtained with the same prisms which had performed so well previously. In consequence the use of these prisms had to be abandoned and a series of experiments made to obtain the spectrum by other means. A Rutherford silvered glass grating of 8640 lines to the inch and a train of six flint glass prisms made by Steinheil were each tried. The grating was not found satisfactory, partly because want of light rendered long exposure necessary, partly because the definition was not so good as had been originally obtained from the bisulphide prisms. The flint prisms gave excellent definition, quite as good as had been obtained with the bisulphide prisms, but there was less light, and it was found impossible to get the line H on the photographic plate, through the train. The dispersion between G and H with the six flint prisms was not quite so great as with the two bisulphide of carbon prisms.

Among the earliest experiments which were undertaken in the new laboratory was a series made to test the performance of a bisulphide prism of Thollon's construction, made by Hilger, of London. This prisms consists of a glass bottle having two plane sides, making an angle of 90° with one another, upon which are cemented two prisms of flint glass 4 by 2 inches on the face, having each a refracting angle of 18°. The refracting edges of these glass prisms are opposed to that of the bisulphide prism. Hence the refracting angle of the compound prism is 54°. The same difficulties were experienced with this prism as with the Rutherford bisulphide prism. Owing to the temperature variations the lines were "woolly" and no definition was possible. It was found that the dispersion power of the Thollon prism was equal to that of about four of the Steinheil flint prisms; and this fact, together with the unsatisfactory character of the results obtained with the train of prisms as well as with the grating, led Dr. Draper to undertake an investigation into the cause of this unsteadiness of the bisulphide with a view to remedying it if practicable.

While using these prisms Mr. Rutherford made an important observation. He noticed that if a good prism which, with a high power, refuses to define the soda line (a more stringent test than soda lines), is violently shaken and then placed in position, it will for a few minutes define beautifully, but gradually settle to its former condition.

It occurred to Dr. Draper, therefore, that possibly the striæ caused by convection-currents produced by inequalities of temperature, and which caused the bad definition, might be destroyed by an active agitation of the liquid. He therefore placed a small propeller wheel in the bisulphide contained in the Thollon prism, passing its shaft through the stopper so that he could drive it at any desired speed by an electro-motor. The result was marvellous: by thus keeping the liquid in agitation all inequalities in its density were prevented, and the definition became excellent. Thus arranged, the Thollon prism was found to be superior, especially in quantity of light, to the Steinheil train of prisms.

Now another source of error was developed. Although when the propeller was running the definition of the bisulphide was not affected by changes of temperature, yet now these changes of temperature, by changing the refractive index of the liquid, caused a continual shifting of

[1] Being an account of experiments made by the late Dr. Henry Draper, of New York.

the position of the lines in the spectrum. It is obvious, therefore, that during an exposure of any considerable duration, such as is often necessary with faint spectra, this change of position of the lines due to temperature-change would absolutely destroy the definition n othe photographic plate. The shifting of the lines on the plate were found to amount to 0·1 inch for 1° F. An even-temperature box of metal containing cotton was made, and the prism arranged within it. The temperature was regulated by a thermostat contained within the box, consisting of a compound bar of brass and ebonite, which turned on or off the gas as necessary. Afterwards one even-temperature box was placed within another, and it was then found that the temperature could be kept uniform for a long time within 0°·1 F., and then the lines did not shift at all so much as the distance between the sodium lines. With this arrangement many hours were taken by the box to settle down to a new temperature, so that, if a change of over 10° F. is to be made in the temperature of the box, it is doubtful whether the spectrum would become stationary in less than twenty-four hours.

The results have a two-fold bearing. In the first place they prove that, by the simple expedient of stirring the liquid in the prism, all striæ may be prevented and the definition rendered perfect. The practical value of this simple expedient is very considerable. The Thollon bisulphide prism, while giving seven-eighths as much dispersion as six flint prisms, gives four times the light in the entire spectrum and eight times the light in the region near G. For photographic purposes, now that the definition can be made permanently sharp and the shifting of the lines prevented, this prism must replace trains of glass prisms, and even gratings, unless these are of large size and are used with telescopes of proportional aperture.

In the second place, this investigation has called attention in a very marked manner to the change in refracting power with change of temperature. This subject has already been discussed by several authors, who agree with the statement of Arago and Neumann, that for glass the law is the reverse of that given for liquids, and that the refractive index increases with the temperature. In the case of the Thollon prism the refractive index increases as the temperature diminishes. As Mendenhall has shown that no change takes place in the angle of the prism with change of temperature, it follows that the observed change of refractive power of the Thollon prism is a differential result due to the excess of the index of the bisulphide in one direction over that of the glass in the other.

It will ever be a source of regret that Dr. Draper did not live to complete the research to which the foregoing investigation was preliminary. With his new and admirably equipped laboratory and with this powerful and thoroughly corrected photographic spectroscope at his command, no one can doubt that he would have secured with it results of the highest value to astronomical, and especially to solar, physics.

## *PREVENTING COLLISIONS WITH ICEBERGS IN A FOG*[1]

THE recent accident to the steamer *City of Berlin* emphasises the importance of devising practical methods of ascertaining the proximity of icebergs in a fog. The precautions adopted by Capt. Laud, though they saved the lives of more than 1400 passengers, and prevented serious damage to the vessel, did not prevent contact with the berg. Even the "look-outs" were unaware of the proximity of the iceberg until it was actually upon them.

Under these circumstances the method proposed by Mr. Frank Della Torre, of Baltimore, deserves consideration. His experiments indicate the possibility of obtaining an echo from an iceberg when in dangerous proximity to a ship. Mr. Della Torre believes that even an object offering so small a surface as a floating wreck may in this way be detected during a fog in time to prevent collision. However this may be, it is certain that his method is worthy of a careful trial at sea, and that preliminary experiments, recently made in the presence of Prof. Rowland, of Johns Hopkins University, and the present writer, have demonstrated the feasibility of producing well-marked echoes from sailing-vessels and steamboats at considerable distances away.

These experiments were made on the River Patapsco, near the head of Chesapeake Bay, at a point about seven miles from the City of Baltimore. The party proceeded down the river in a steam-launch to the selected place, where the distance from shore to shore appeared to be about three miles.

The launch was kept so far from land as to prevent the possibility of mistaking an echo from the shore for one produced by a passing vessel.

The apparatus employed consisted of a musket, to the muzzle of which a speaking-trumpet had been attached. This gun was aimed at passing vessels, while blank cartridges were fired. After a longer or shorter time, according to the distance of the vessel, an echo was returned.

The ordinary river-steamboats, and schooners with large sails, returned perfectly distinct echoes, even when apparently about a mile distant. At shorter distances the effects were, of course, still more striking.

In order to test the effects under the most disadvantageous circumstances, blank cartridges were fired in the direction of an approaching tug-boat. The surface presented was, of course, much smaller than if the boat had presented its broadside to the launch. As the boat approached bow on it corresponded to a target somewhere about six feet square, presenting a convex surface to the impinging sound-wave. Even in this case a feeble echo was perceived when the boat was at a considerable distance (estimated to be nearly one-quarter of a mile). That any echo should have been perceived at all under such circumstances was a surprise. The sound was heard only by the closest attention, but in the case of larger vessels the effects were very distinct and striking.

Experiments were made which demonstrated the fact that the speaking-trumpet attached to the gun was of material assistance in giving direction to the sound-impulse, and in intensifying the audible effect.

Mr. Della Torre claims that a steam-whistle or siren, combined with a projecting apparatus like a speaking-trumpet, will prove as efficient as the gun.

During the experiments on the Patapsco River a curious rumbling effect like the rolling of thunder was often observed, which continued for some seconds. A similar sound was also noticed, as an echo from a well-wooded shore; but the effect alluded to above could not have been due in any way to the land, as the sound commenced immediately upon the firing of the gun, whereas the shore was distant at least a mile or a mile and a half.

The sound was probably due to the presence of ripples on the surface of the water, as the effect was much less marked when the surface was smooth. Such a sound might prove a disturbing element of importance in a rough sea, but would hardly be sufficient to prevent the detection of an echo from a large iceberg. Had shots been fired periodically from the bow of the *City of Berlin* it can hardly be doubted that the presence of an obstacle ahead would have been discovered in time to prevent the collision that actually occurred.

ALEXANDER GRAHAM BELL

[1] From *Science*.

## THE AURORA[1]

I.

MR. TROMHOLT has rendered a great service to science by the travels and observations recorded in these volumes; indeed, it would not perhaps be going too far to say that we have here, brought before us in the most interesting manner, one of the best organised attempts to study the aurora that has been made for many years, the credit for which must be given to the organisers of the International Polar Research Expedition of 1882-83. Mr. Tromholt's duty was to observe all auroral phenomena in the Lapp settlement of Koutokæino, and above and beyond this to observe in such a way that, in combination with other observations arranged for at the Norwegian station at Bossekop in Finmarken and the Finnish one at Sodankylä in the centre of Finland, certain conclusions might be arrived at regarding the height at which the various displays take place.

The results, however, recorded in these volumes are by no means limited to the height of the aurora. The constant study afforded to Mr. Tromholt and his *confrères* at the other stations of one of the most awe-inspiring phenomena which it is given to man to witness have permitted generalisations to be reached and hypotheses to be broached of the greatest scientific interest; and this must be our excuse for dwelling on the general results of this recent work in the present article, including also a notice of those of Nordenskjöld in the *Vega* Expedition 1878-79.

Let us begin by considering the general phenomenon of an aurora as seen in Northern Europe. Mr. Tromholt gives the following general description of a great display:—

"It is a lovely evening in spring or autumn. The light is fast fading away in the west, and one star after another comes out of the azure sky. Suddenly a peculiar vibrating luminosity appears high up in N.E., now with a soft purple tinge, and now diffused with long narrow streamers, reaching to the Pole star, or beyond. It is wafted to and fro like a curtain before a light breeze, and its light becomes more and more intense as Night spreads her dark veil over the sky. Suddenly the luminous cloud is furrowed from one end to another by a bunch of streamers, the lower, emerald-green ends of which rest almost on the horizon, while the upper diffuse points, which flame with a purple lustre, reach right up to the Zenith. Streamer oscillates by streamer, more and more follow, and, with a rapidity almost startling, the aurora expands westwards, and shortly after the whole northern sky is a bath of fire. Like a curtain woven of light and colour the streamers hang fairy-like in the air; here and there they form large graceful folds and sway to and fro in wonderful beauty, as if the wind played on the radiating drapery. Red and green play alternately in the lower border of the curtain. For a few minutes longer the marvellous play of light lasts, the varying forms, colours, and motions charm the mind as much as the eye—the forces are then exhausted, the lovely picture grows more and more obscure, and the forms are dissolved into large soft clouds of light, covering nearly the entire northern half of the heavens.

"Down by the horizon there is still, however, great activity, as here a couple of arcs have formed, the constant-changing play of which enchains the spectator during the *entr'acte* between the past and coming scene of the sublime drama which Nature performs on the great stage of heaven: now faint, then strong, soon symmetrical, soon serpent-like, in one moment split into three or four arcs, and again gathering into one, now woven with all the lovely colours of the rainbow, now throwing forth rays and resembling the ornamental pipes in an enormous organ—such is the spectacle I gaze on.

[1] "Under the Rays of the Aurora Borealis." By S. Tromholt. Edited by Carl Siewers. (London: Sampson Low and Co., 1885.)

"At this moment a narrow, white streamer suddenly leaps up from the horizon in the east, a similar one appears in the west; they both grow rapidly in length, their points meet, and a grand arc spans the sky right above the observer. Simultaneously two long and broad sheafs of streamers, woven of white and red filaments, develop at the bases of the arc. The luminosities on the northern sky again catch fire, and soon after the whole heavens in the north is again ablaze. Quicker and quicker the motions become and intenser the colours, higher and higher the streamers travel, the points approaching the great arc, which is moving slowly southwards. Other groups of streamers form at greater altitudes, in east and west, and the luminous masses cover more and more of the sky. Now a number of white bands suddenly appear overhead, shoot right across the sky from east to west, and then rush southwards, and vanish. By this time the luminous masses have crossed the zenith, the points of the streamers meet in a spot high in the southern sky, while in the east and west the sphere of the streamers moves gradually southwards. A wonderful spectacle is now presented to view. In every direction the whole sky is covered with bunches of streamers, all of which point to this spot—the magnetic zenith—and transform the vault of heaven into one gigantic lustrous cupola, the beauty of which no pen can describe, no brush depict. All the marvellous *nuances* of colour of the rainbow contribute to ornament the vault; here is the tender green of the emerald, the grand purple of the ruby, and the charming blue of the sapphire, all blended together in a thousand shades. Here gamble a flock of yellow-green flames, and there mighty pillars rise as if to support the luminous vault, while yonder the sky is covered with a transparent drapery shot with red, behind which dazzling white streamers stand forth. It is the auroral corona.

"A lovelier spectacle is not given the human eye to behold; he who has not seen it cannot form an idea of its magnificence—it defies description.

"For a moment the glorious, luminous vault remains thus in majestic beauty, then the supporting arches tremble for a moment, and fall, the faint light-clouds remaining in the southern sky vanish, and the aurora recedes to the northern sky. Here the streaming and play of colour continues for a while in manifold variation; but the area of the luminosity grows smaller and smaller, and moves steadily downwards to the horizon. A remarkable phenomenon now occurs in the soft luminosities, which still stand high in the northern sky: they appear to leap upwards with the rapidity of lightning, and then disappear; in several other spots similar clouds come forward and chase each other over the sky. The eye is hardly able to follow their strange gambols. Again the streamers grow in length, the light-clouds cease their play, and once more the streamers approach the zenith. But now they do not cross it; they remain in majestic rest for a few seconds, and then slowly disappear.

"Hour after hour this marvellous display continues in the northern sky, now stronger now fainter, and often it does not cease before the first streaks of dawn appear in the east."

It must not be imagined, however, that the displays generally are of this brilliancy; auroræ are generally much weaker, and in these cases the phenomena are different. Here is a general description of a weak aurora:—

"The sun set some hours ago. The purple glow in the west has disappeared, myriads of stars stud the dark canopy. Far down on the horizon, in north-west and north, lies a faint vague cloud of light, upwards and downwards fading into the sky . . .

"Soon after, tiny spots of intense light begin to appear in the luminous cloud, while at times the entire oscillating luminosity disappears from the sky. But still the light is

increasing in force, and in a few moments a broad arc of light stretches along the north-western sky, resting both its bases on the horizon in north-east and west, and whose highest point lies a few degrees above the horizon in north-north-west. Upwards the light is gradually lost in the sky, downwards the intensity is greatest, and the lower edge stands sharply out. Solitary, stronger spots of light, now here, now there, travel, with an unsteady motion, at times right or left through the arc, again to disappear in the cloud. Following the arc attentively it will be seen to rise gradually, its point of culmination travels upwards, and the distance between the two bases becomes greater and greater. The colour of the light is nearly white, with a weak yellow-green tinge, which is easily discovered by comparing it with the cold, white light of the Milky Way. Suddenly energy and life become manifest in the phenomenon. The lower edge of the arc changes in an instant into a small, intense stream of light, which is sharply defined by the dark space below—the 'dark segment'—appearing black or faintly violet. Higher up the luminosity gathers into a broad, but fainter arc, running parallel with the other. Only for a moment does the aurora retain this distinct form; stronger waves of light begin to appear in the lower arc, which soon generate groups of intense, short, and perpendicular streamers, reaching the upper arc, which sway right and left, at the same time travelling east or west. Below, the ends, strong in light, cut down into the dark segment, whose sharp curve is thereby broken. Of the upper arc only fragments now remain, while the lower is dissolved into quivering bunches of streamers, which die out one after another as new ones are being lit in their place. They move, here slowly, there quickly, oscillating apparently to the right or left, but it is impossible to say whether it is really the streamers which move horizontally, or merely the light which passes from streamer to streamer without the latter shifting their position.

"But this display is only of short duration, the streamers soon lose their motion and light, and in a few minutes there remain only some pale, diffuse luminosities. Slowly these now gather, until another arc is formed. It is not so symmetrical, and does not possess the classical rest of

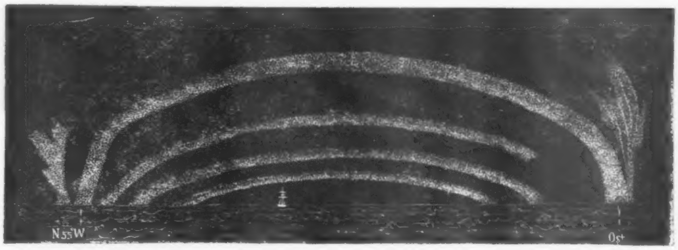


FIG. 1.—Auroral Arcs, Nordenskjöld.

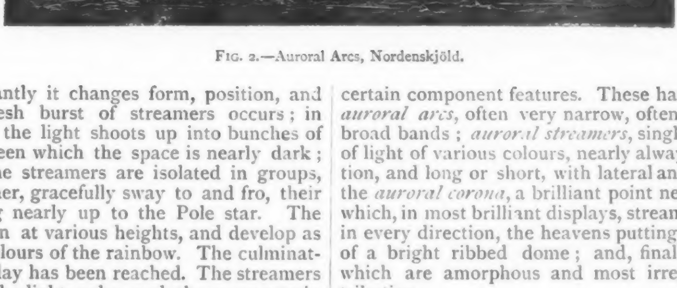


FIG. 2.—Auroral Arcs, Nordenskjöld.

the former. Constantly it changes form, position, and intensity until a fresh burst of streamers occurs; in two or three places the light shoots up into bunches of long streamers between which the space is nearly dark; in another second the streamers are isolated in groups, which, like the former, gracefully sway to and fro, their faint points reaching nearly up to the Pole star. The lower ends are broken at various heights, and develop as they move the soft colours of the rainbow. The culminating point in the display has been reached. The streamers vanish one by one, the light pales, and the remnants in the sky again form into a long, low-lying arc. Only for a short time it retains this pronounced form, the edges become obscure, the centre follows, and finally the last faint indications of the aurora sink into the unfathomable darkness of space."

Now the great variety in the appearance of the aurora depends to a great extent upon the various mixtures of certain component features. These have been designated *auroral arcs*, often very narrow, often degenerating into broad bands; *auroral streamers*, single or multiple shafts of light of various colours, nearly always vertical in direction, and long or short, with lateral and vertical motions; the *auroral corona*, a brilliant point near the zenith, from which, in most brilliant displays, streamers seem to radiate in every direction, the heavens putting on the appearance of a bright ribbed dome; and, finally, *auroral clouds*, which are amorphous and most irregular in their distribution.

Before we proceed further with more detailed descriptions of these various features, each of which in the main is seen more richly from certain positions on the earth's surface than in others, or puts on different aspects, a word must be said about the magnetic basis of the whole phenomenon, since it has long been known to be connected with the *magnetic* poles of the earth.

In the first place, the mariner's compass or decli-

nation-needle indicates the direction of the magnetic pole. At the present time in London the needle points 18° to the west of true or astronomical north; hence, if auroral arcs were seen here to-night, their highest points would be nearly certain to be west of north. Next, the dipping- or inclination-needle (a very cheap and admirable form of which is now sold by Mr. Casella) points to the magnetic zenith, which now in London lies 22° north of the true or astronomical zenith, in the magnetic meridian joining the north and south magnetic points of the horizon. Hence, if an auroral corona were seen here to-night, it would be nearly certain to lie in a point 22° north of the zenith.

Let us limit ourselves for the present to the arc. In our latitudes, as has been said, it is seen to the west of north, generally low down near the horizon; but in the far north on the same magnetic meridian as ourselves it is seen east of south, while also in the far north, but in a widely different longitude—that of Behring's Straits—it is seen north-north-east.

Evidently, then, this arc—this "common auroral arc," as it has been called by Nordenskjöld—is produced by a ring at some height between us and the north pole, but its centre does not lie at the north pole. Putting such observations as those referred to together, Nordenskjöld inferred the centre to be near the magnetic pole but not at it, in 81° N. lat. and 80° W. long., the thin ring of light having a radius of 18° and a height of 200 kilometres.

This, then, was Nordenskjöld's main conception—an immovable common arc (a permanent stria, to speak in vacuum-tube language), though he acknowledged additional ones sometimes, and shows by his observations that they are not always concentric.

He also attempted to explain the frequency and positions of arc auroræ in different places by dividing the polar lands into five concentric regions (see NATURE, vol. xxv. p. 368).

In Mr. Tromholt's volume we find what may prove to be an immense advance on this view. He holds that *the auroral zone moves northwards and southwards daily, yearly, and eleven-yearly.*

Again, to speak in vacuum-tube language, instead of one rigid stria, we may have many striæ, and these moving towards or away from the auroral pole as ordinary striæ move towards or away from the negative pole.

Next, as to the proofs of this movement, some more quotations from Mr. Tromholt may be given:—

"The daily period is apparent by a maximum of frequency and development which in most places in the globe occurs one to two, or three hours before midnight. This maximum seems, however, to occur *later* the nearer we approach the magnetic pole. This will be clear from the following series, in which the figure in parenthesis denotes the geographical latitude and the other the hour when the aurora attains its maximum in the place named:—

"Prague (50), $8\frac{3}{4}$; Oxford (52), $9\frac{1}{4}$; Kendall (54), $9\frac{3}{4}$; Makerston (56), $9\frac{1}{3}$; Upsala (60), $9\frac{1}{2}$; Christiania (60), 10; Bergen (60), $9\frac{4}{5}$; Bossekop (70), $10\frac{1}{3}$; Pustosersk (70), 11-12; Quebec (47), $10\frac{1}{4}$; Fort Carlton (53), $12\frac{1}{4}$; Fort Simpson (62), 12; Point Barrow (71), $13\frac{1}{2}$.

"For the Aurora Australis continuous series of observations are almost entirely wanting. It seems, however, from the fragmentary material which we possess, that the daily period for this does not differ from that of the Aurora Borealis.

"The individual types of the Aurora Borealis seem, like the phenomenon itself, to be confined to periods, and to attain their greatest frequency and highest development at certain periods. Thus, it appears from the observation of the previously mentioned French expedition to Bossekop, that the arcs appear on an average at 7h. 25m.; the streamers at 8h. 26m.; the auroral clouds at 11h. 18m.; the auroral waves between 13h. 12m. and 13h. 53m.; the intensest colours at 10h. 11m., and the greatest brilliancy between 10h. and 11h."

Next as to the yearly change.

Weyprecht was the first to advance the view that the auroral zone is furthest south at the equinoxes, and furthest north at the solstices. On this point Mr. Tromholt writes:—

"My researches have led me to endorse Weyprecht's theory. I feel satisfied that the *Aurora Borealis moves towards the autumnal equinox southwards, and then northwards, reaching its furthest northern limit about solstice. After this it again moves southwards, being in its most southern position at the vernal equinox, when the movement is again in a northerly direction.*

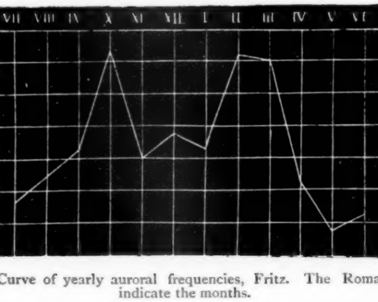


FIG. 3.—Curve of yearly auroral frequencies, Fritz. The Roman figures indicate the months.

"From this it follows that the two maxima occurring in the Temperate Zone at the equinoxes must approach each other more the further north the point of observation is situated. This is, in fact, the case. As some examples, I may mention that, whilst the two maxima occur in March and September in St. Petersburg, Åbo, Stockholm, Christiania, Worcester (Mass.), and New Haven, they occur in February and October in Aalesund, Newberry, Quebec, and Newfoundland; in December to January in Hammerfest and in January at Fort Reliance. Very instructive in this respect are also the observations from the three Greenland stations: Upernivik, Jacobshavn, and Ivigtut. At Ivigtut, the southernmost of the stations, the yearly maximum must certainly be said to occur in January, but there is a second maximum towards the autumnal equinox. At Jacobshavn, eight degrees further north, there is but one distinctly marked maximum, in January, and at Upernivik, the northernmost of the stations, the maximum falls at the winter solstice more marked and dominant than anywhere else in the world."

(*To be continued.*)

## THE ECLIPSE OF CHUNG K'ANG

IN China an eclipse of the sun is, and has in all ages been, considered as a bad omen. Indeed anything which disturbs the regularity of the movements or appearances of the heavenly bodies is so considered. "On the first day of the last month of autumn the sun and moon did not meet harmoniously in Fang." This passage occurs in the ancient classic, the "Shu Ching," in the "Yin Cheng," one of the books of the Hsia dynasty. Chinese commentators say that this passage refers to an eclipse of the sun in Fang, the fourth of the Chinese twenty-eight constellations. The last month of autumn, according to the Hsia Calendar, is the ninth month, the month after that month which contains the autumnal equinox.

The constellation Fang extends from about $\pi$ to $\sigma$ Scorpii, a distance measured along the ecliptic almost

equal to 5°. Approximately the limits of Fang were as follows:—

| | | | |
|---|---|---|---|
| 2250 B.C. | between | 184° 12′ | and 189° 12′ |
| 2150 „ | „ | 185 34 | „ 190 34 |
| 2053 „ | „ | 186 56 | „ 191 56 |

An eclipse near the constellation Fang will satisfy the conditions of the text, as at that early period, and for a great many centuries after, the Chinese were unable accurately to determine the position of the sun among the stars.

The date of the accession of the Emperor Chung K'ang, during whose reign this eclipse is said to have occurred, is unknown. Indeed all the dates in Chinese history before the Chou dynasty are unknown, the dates given in the common chronology being erroneous. The great importance of fixing the date of this eclipse is therefore apparent.

In all probability Chung K'ang reigned some time between the years 2050 B.C and 2158 B.C. I have therefore examined all years between these two dates on which an eclipse of the sun, in the constellation Fang, and on the first day of the ninth moon might be looked for.

Mr. Newcomb has published tables for the calculation of eclipses between the limiting dates 700 B.C. and 2200 A.D. I have extended these tables so as to embrace all eclipses of the sun between the dates 2200 B.C. and 2200 A.D. These tables thus extended I have used in the examination of this eclipse.

We might expect such an eclipse on or near the following dates:—

| | | |
|---|---|---|
| −2154 + ·64 years. | ... ... | −2164 + ·82 years. |
| −2135 + ·25 „ | ... ... | −2145 + ·43 „ |
| −2117 + ·86 „ | ... ... | −2126 + ·04 „ |
| −2098 + ·47 „ | ... ... | −2108 + ·65 „ |
| −2079 + ·08 „ | ... ... | −2089 + ·26 „ |
| −2061 + ·69 „ | ... ... | −2071 + ·87 „ |
| −2042 + ·30 „ | ... ... | −2052 + ·48 „ |

The dates on the left are the years and fractions of a year on which the ascending node is in longitude 180°, those on the right the years on which the descending node is in longitude 180°. The minus sign indicates B.C.

The situation of the capital of Chung K'ang is a disputed point. Some hold it was at An Yi Hsien, in Shan Hsi, latitude 35° 8′ N., and longitude about 111° 30′ E. of Greenwich; others say it was at T'ai K'ang Hsien, in Honan, latitude 34° 7′ N., and longitude about 115° E. of Greenwich.

Gaubil calculated the eclipse of the year 2154 B.C. to be the one in question. During this eclipse, however, it was night in China.

On October 22, 2136 B.C., the ninth of the cycle of days, the day Yen Shen, there was an eclipse of the sun, visible in the north of China. At An Yi Hsien it commenced about 10 a.m., and was over about half an hour after noon. The magnitude was about ·5. The longitude of the sun at the moment of true conjunction was 191°·38, so that the eclipse took place very near Fang. The day was the first of the ninth moon.

In the following year, 2135 B.C., on October 11, the third of the cycle of days, the day Ping Yin, there was an eclipse of the sun, also visible in the northern hemisphere. At An Yi Hsien the eclipse began about 4.30 p.m., and lasted till about 7 p.m. The magnitude was ·58. At the time of conjunction the longitude of the sun was 180°·28, so that the eclipse took place near Fang. Strictly speaking, October 11 was the first day of the eighth moon, but we need not expect the Chinese at that early date to have been able to determine the time of the equinox to a few hours.

We meet with no other eclipse visible in the north of China, and fulfilling the required conditions, till the year 2071 B.C. On October 23, the fifty-first of the cycle of days, the day Chia Yin of this year, there was an eclipse of the sun. At T'ai K'ang Hsien it began a few minutes after seven in the morning, and was over about 9.30 a.m. The magnitude was ·34. At conjunction the longitude of the sun was 193°·2. This eclipse also satisfies the required conditions near Fang, and occurring on the first day of the ninth moon.

The eclipse of the year 2127 B.C. deserves consideration, as it is generally considered to have been the eclipse in question. On October 13 of this year, the forty-seventh of the cycle of days, the day Keng Hsii (all dates are given according to the Julian calendar), there was an eclipse of the sun. The "Bamboo Books" say that this eclipse took place in the fifth year of Chung K'ang, the thirtieth of the cycle of years in the An Sunn and on the first day of the ninth month, the day Keng Hsii (forty-seventh of cycle). This account of the eclipse must have been the result of an after-calculation, and is a proof of the wonderful accuracy to which the Chinese astronomers attained in calculating back past eclipses. In this eclipse they are right in every particular. However, this eclipse was not visible in China so far south as either An Yior T'ai K'ang. The following table, which approximately gives the southern line of simple contact of the eclipse, shows this clearly:—

| Latitude | Longitude |
|---|---|
| 66° 14′ N. | 96° 10′ E. |
| 60 23 N. | 139 27 E. |
| 55 33 N. | 152 28 E. |
| 52 7 N. | 158 35 E. |

From the above investigation we see that the eclipse referred to in the "Shu Ching" in all probability must be that of one of the years 2136 B.C., 2135 B.C., or 2071 B.C.; which of these dates is to be taken must be determined by other considerations. The eclipse of the year 2136 B.C. may be the one in question. It occurred in the middle, the busiest part, of the day. A total eclipse would agree better with the accounts as given in the "Shu Ching." The hurry and bustle occasioned by the total want of preparation to perform the customary rites, and the penalty of death inflicted on the two astronomers, Hsi and Ho, seem to point to some adequate cause. However, I believe a great part of the account as given in the "Shu Ching" is legendary. It is taken for granted that Hsi and Ho were able to predict eclipses, and it is stated they were put to death because, giving themselves up to pleasure, they neglected their proper duties. But the Chinese at that early period, and for many centuries after, were not able to predict eclipses. They were not even able to observe the place of the sun with any degree of accuracy, which is proved by their Calendar so often falling into confusion. That the account of the eclipse itself is true, there is no reason to doubt. It is referred to in the "Tso Chuan," a book written about the time of Confucius. However, that the astronomers Hsi and Ho were put to death because they failed to predict the eclipse, appears very doubtful. It is much likelier they were put to death for rebellion, or some other political reason. Summing up the above investigation, we see that between the years 2164 B.C. and 2042 B.C. no eclipses of the sun in Fang, and on the first day of the ninth moon, were seen in the north of China, except in the years 2136 B.C., 2135 B.C., and 2071 B.C.

P.S.—In NATURE, vol. xxxi., p. 91, the eclipse of Thucydides is mentioned as having occurred on August 3, 431 B.C., and that, calculating this eclipse with Hansen's tables, the greatest phase falls at 5h. 9m. p.m., and the magnitude is ·75. Using Newcomb's tables of eclipses, I find the greatest phase falls at 6h. p.m., and that the magnitude was ·91.

S. N. K.

## NOTES

SIR L. PLAYFAIR asked the Secretary to the Treasury on Monday whether any answer had been given to the application of the Marine Biological Association for aid in establishing a station on Plymouth Sound to investigate the marine fauna and flora, especially in their relation to the food-fishes of these islands, and for which station 8000*l*. had already been subscribed from private resources. Sir H. Holland in reply stated that this application had received much consideration both from the present Government and its predecessors, and a letter was written to the association a fortnight since in which the Treasury undertook in general terms to ask Parliament for an annual grant for a term of years in aid of their undertaking, on condition that their work should be carried on in full concert with the Scotch Fishery Board, to whom Parliament has already granted considerable sums for similar objects. In the view of the Government these two bodies must be considered as working together towards the common benefit of the fishermen and fish consumers of the three kingdoms. On the whole this is satisfactory. No doubt it is desirable to form a central authority for dealing with fishery statistics and the scientific problems of fisheries for the three kingdoms. But this will take time; and in the meanwhile it is to be expected that the Marine Biological Association will receive Government aid so as not to delay its useful work. The condition as to common action and harmony with the Scotch Fishery Board is very proper and is not likely to give rise to any difficulty. The leading and we believe only scientific member of the Scotch Fishery Board, Prof. Cossar Ewart, is a member of the Biological Association, and will no doubt co-operate in every way with that body. The Marine Biological Association is now a very large and weighty body, comprising all British zoologists. It is not to be expected that it should be controlled in any way by the Scotch Board, nor are we sure it would desire to interfere with Prof. Ewart's valuable researches. But there need be no difficulty, we should think, about consultation and harmonious action. With the expected Government aid the Biological Association will be able to spend the greater part of its 8000*l*. on building and equipping a first-rate laboratory on the splendid site granted to it by the War Office. It will be able to carry out a definite series of investigations under the guidance of Profs. Moseley, Lankester, Günther, Huxley, and other leaders of the Association, and may be expected, step by step, to build up that knowledge of sea-fishes which is so much needed. The work to be done will no doubt be thoroughly systematised and apportioned to different workers. It should be remembered that the Marine Biological Association is not local: it aims at carrying on work on various parts of the English, Scotch, and Irish coasts, and in time, indeed, may become in all respects a national Association.

THE Astronomische Gesellschaft meets this year at Geneva from August 19 to 22. The first meeting will be held at 10 a.m. on the 19th, in the hall of the Aula of Geneva University. Geneva has been chosen for the eleventh meeting of this Association on account of its central situation. Although founded at Heidelberg twenty-two years ago, the Association includes among its members astronomers of nearly all civilised countries.

THE Paris students are making extensive preparations for celebrating the 100th birthday of M. Chevreul, the veteran chemist, who has been a member of the Academy of Sciences since 1826.

THE third session of the International Geological Congress, which was postponed last year on account of the cholera on the Continent, is fixed to be held this year on Sept. 28 at Berlin, under the honorary presidency of the veteran geologist of Rhineland, Dr. H. von Dechen. The President of the Organising Committee is Prof. Beyrich, and the General Secretary M. Hauchecorne, 44, Invalidenstrasse, Berlin.

To meet the requirements of ladies going up for the Preliminary Scientific or the Intermediate or Full B.Sc. examination at the University of London, under the new regulations, the Council of Bedford College, York Place, Baker Street, London, have arranged for a complete course of instruction in biology, to commence next October. Mr. A. G. Bourne will give lectures in animal biology, and will also have classes for demonstration. Mr. A. W. Bennett will lecture on vegetable biology, and Miss Mary Forster, of Newnham College, will give practical demonstrations twice a week. Provision is also made for adequate instruction in other branches of science required for the same examinations—viz. mathematics, physics and chemistry, the two latter including laboratory work.

THE secretary of the Royal Horticultural Society writes to say that the council of his society are prepared to offer their co-operation and assistance to such of the colonies as may desire as a feature of their courts examples of the indigenous flora in vestibules or plant-houses. The council, believing that collections of ornamental and economic plants in a growing state, and of fruits, would be of much interest and value, will be ready to give advice and practical assistance in preparing, arranging, and carrying out such illustrations, to any of the colonies who may apply to them.

THIS season the rains have set in early and with unusual force in Southern India and Burmah, and about the usual time in Lower Bengal, while in Western India they have been later in commencing and are deficient in amount. Thus far, therefore, Mr. Blanford's forecast of this year's south-west monsoon, founded on last winter's snowfall on the Himalayas, has been amply justified.

AN invention, which it is anticipated will be of importance in future warfare, was on Monday night exhibited in the grounds of the Albert Palace by Mr. Eric S. Bruce, the inventor. It consists of the application of electric lighting to balloons, by means of which signals may be flashed at night over very wide areas. Before giving a practical demonstration of the working of his invention, Mr. Bruce delivered a brief lecture in the concert hall of the Albert Palace, in which he stated the results of his experiments and explained the manner in which he had arrived at them. The invention consists of an ordinary balloon made of a material as translucent as possible (in the case of the one at present on exhibition the material is cambric) in which are fixed a number of incandescent lamps. The balloon is a captive one, and the rope which secures it is also utilised for conveying the electric current to the lamps inside the balloon. The Morse system of telegraphy is employed for the signalling, which illuminates the balloon with flashes of light of longer or shorter duration. The invention dates back only two months, and the experiments were made with a large balloon for the first time last night, and were completely successful. It is proposed to continue the exhibitions of signalling for a month. The chief obstacle to be overcome in introducing the electric light into the balloon was that occasioned by the highly inflammable nature of the gas with which the balloon is inflated. This has, however, been successfully surmounted. During the evening several sentences, including "God Save the Queen," "Rule Britannia," and "Health and Happiness to Princess Beatrice," were flashed from the balloon.

ON Thursday evening last, July 16, Finsbury Technical College was *en fête*, the students having organised a *conversazione*

to mark the conclusion of the work of the session. The programme was of a very varied character, including, in addition to a large number of scientific items, a concert given in the Chemical Lecture Theatre, and a play and dance in the large hall of the Middle Class Schools in Cowper Street, which had been kindly lent for the occasion. The evening's entertainment proved most successful in every way, great credit being due to the secretaries of the various Committees, and especially to Mr. H. Newman Lawrence, the general and organising secretary, for the efficient manner in which all the arrangements were carried out. Most of the rooms were filled with exhibits of apparatus, the whole building being lighted by electricity, and the machinery, workshops, &c., in full action. In the course of the evening a lantern exhibition of polariscopic objects was given in the Physical Lecture Theatre by Prof. S. P. Thompson, who had also lent for exhibition various telephones, a phonograph, an "electric light compass" for detecting the direction of a current in a wire, a "cymatograph" (an instrument for compounding the resultant of two parallel, simple, harmonic waves), and a collection of historical electric-telegraph apparatus. In the Chemical Department Prof. Meldola exhibited a series of new organic products obtained in the course of recent researches. Messrs. Hopkins and Williams exhibited a series of chemical preparations. A large number of microscopes with objects were exhibited in one of the rooms by Mr. Beck. Amongst the electrical exhibits were a model telpher line by the Telpherage Company, the valve telephone lent by the New Telephone Company, Cardew's voltmeter lent by Messrs. Paterson and Cooper, a selection of ammeters, switches, incandescent lamps, &c., lent by Messrs. Woodhouse and Rawson and by Mr. Swan; and accumulators, dynamos, &c., made by the students of the Electrical Engineering Department. In the Trade Classes Department Mr. C. T. Millis exhibited some new geometrical models and students' paintings; models, and drawings were exhibited by the Applied Art Department. It is proposed to form an "Old Students' Association" in connection with the College, and the success which attended the first attempt at a public entertainment has encouraged the professors and students to make an annual institution of it.

MR. HELE SHAW has been unanimously appointed to the new Chair of Engineering in University College, Liverpool. Mr. Shaw began his career by taking the Senior Whitworth Scholarship in 1876, which was followed by many other honours while pursuing his engineering studies. In the present year he was awarded the Watt Gold Medal and Telford Premium by the Institution of Civil Engineers.

ACCORDING to the *Times* Roman correspondent an interesting discovery, illustrating the commerce and the luxury of ancient Rome, has been made close to Monte Testaccio and the English cemetery. The whole of the district to the west of the Aventine outside the Porta Tregemina was occupied by granaries and warehouses for the storage of imports of all kinds. Between the northern side of Monte Testaccio and the Tiber there still exist colossal remains of the great emporium built by Marcus Emilius Lepidus and Emilius Paulus nearly 200 years before the Christian era. In the year 1868 a considerable portion of the quays was discovered, together with some 600 blocks, many of them of large size, of rare, variegated marbles of all kinds, lying just where they were landed from the galleys which had brought them from Numidia, the Grecian Islands, and Asia Minor fifteen centuries ago. Now, in the course of the building operations in this locality, two warehouses have been discovered, one filled with elephants' tusks and the other with lentils. It is curious to find such products stored side by side; but as bags of lentils were sometimes shipped as ballast, they may have served that purpose. The discovery would have been a very valuable one if, unfortunately, the ivory had not been much decayed.

WE have received from the Bureau des Longitudes ephemerides of circumpolar and moon culminating stars for the present year and an account of the determination of longitude between Paris and Bregenz, a town situated near the western boundary of the Austro-Hungarian Empire; a high value is claimed for the result.

MR. CLEVELAND, the President of the United States, has given his assent to the nomination as American Ambassador at Rome of Mr. Stallo, a German by birth, but long since a naturalised American citizen. He devoted himself exclusively to scientific pursuits in his younger years, but was persuaded by his friend Draper to join the Bar, where he distinguished himself without relinquishing his former avocation. He is the author of several scientific works; the last was on "The Concepts and Theories of Modern Physics," noticed in NATURE, vol. xxiv. p. 321.

OWING to the frequency of tornadoes in some parts of the valley of the Mississippi, we understand that a number of caves have been bored in some parts of the country to afford shelter to travellers chancing to meet such dangerous phenomena on their way.

ON July 10, at about noon, a wonderful mirage was seen on Lake Wettern, in Sweden, by a number of people between the villages of Fogelsta and Vadstena. A small island in the lake appeared as if covered with the most gorgeous flora and tall gigantic trees, forming great groves, between which buildings having the appearance of the most splendid palaces were seen. The Sandö, another little island, seemed to rise out of the sea many times its actual height, its sandy shores looking like lofty castellated walls. It had the exact appearance of a mediæval fortress enclosed by four walls. Two other little islands, Åholmen and Risön, appeared also as lofty towers above the water. The mirage lasted for nearly half an hour, when it disappeared somewhat rapidly.

MR. CLEMENT L. WRAGGE is arranging for the establishment of a meteorological station in Northern Queensland and New Guinea. He hopes to establish an observing station at Port Moresby. An assistant will carry on the work of the Torrens Observatory. Mr. Wragge is also arranging for the continuance of his observatory on Mount Lofty.

ON Tuesday morning last week an earthquake occurred in Eastern and Central Bengal which is said to have been the severest one experienced by the inhabitants for forty years. The shocks lasted for nearly a minute. In Calcutta the houses rocked and cracked and the plaster fell in large quantities. There was general consternation, the people all rushing out of doors. A wave was raised in the river like a bore, causing some anxiety with respect to the shipping. Luckily no accident occurred, and no damage was done beyond the cracking of the walls of some old houses; but had the shocks lasted some seconds longer the city would probably have been laid in ruins. Some of the up-country stations were less fortunate. At Serajgunge a chimney belonging to some jute mills fell. In many other places some of the houses fell and people were killed. Twenty-five deaths are reported to have occurred at Aheripore, five at Bogara, eleven at Azimgunge, and several at Dacca. The following morning another shock was felt in Cashmere which did some injury. According to the latest reports the earthquake caused altogether seventy deaths in Bengal.

A SHOCK of earthquake occurred at Velez-Malaga on Monday night last week, but no damage was caused. A smart shock of earthquake occurred at Smyrna at 1.30 a.m. on July 15. The vibration was also slightly felt at Chesmé.

ON June 30, at about 10 a.m., after a severe thunderstorm with heavy rain had passed over Stockholm, a little bright

cloud was seen sailing in an easterly direction about 30° above the horizon, which at about 11 o'clock was suddenly illuminated by the intensest bright forked lightning, illuminating the cloud and the clear sky for upwards of half an hour, without any thunder being heard. The light was brighter than the electric light. Similar phenomena are very rare in these latitudes, and are believed to augur a good harvest. On the 12th inst. another phenomenon, perhaps of volcanic origin, was observed at Norrköping, the water in the river being seen suddenly to rise, and three large waves with frothy crests to roll thunderingly up the stream. After the lapse of a few minutes three smaller followed, of which the first only was froth-crested. Five minutes later it was observed that the water in the river had fallen quite four inches. The waves did not reach as far as the shore, and no earthquake or subterranean noise was felt or heard. After a quarter of an hour the river had resumed its wonted appearance. The phenomenon, it is suggested, may also have been caused by a sudden subsidence in the river basin.

A MOVEMENT is on foot in Christiania, at the instance of the Society for the Promotion of the Norwegian Fisheries, for the establishment in the Christiania fjord, near Dröbak, of a biological station for the hatching of sea-water food-fish and salmon, in consequence of the great success of other stations along the coast. In a report on this subject by Herr A. Landmark, Chief Inspector of the Norwegian Fisheries, he draws special attention to the great development of the salmon and trout fisheries of Great Britain and Ireland, in consequence of the care and attention paid to them in this country.

UPSALA UNIVERSITY has just received a somewhat valuable present in the shape of a collection of Scandinavian, Icelandic, and Greenland eggs, specially remarkable for its completeness and excellent preparation. Among some of the rarest are eggs of *Tringa islandica*, *Phalaropus platyrhinchus*, and *Lestris pomerina*.

AN automatic bichromate battery has recently been produced by Messrs. Woodhouse and Rawson, the dimensions of which are only $7\frac{1}{2}'' \times 1\frac{3}{4}'' \times 8\frac{1}{4}''$, and weight 6 lbs. One charge will light a 5-candle power lamp for about two hours. The electrodes are attached to an ebonite plate supported in position over the liquid by the upper edge of the containing case, within which is placed a more shallow case, constituting the liquid reservoir. The reservoir itself is free to move up and down without any possibility of disarrangement, and rests upon a small roller connected with a lever at the bottom of the case. By moving this latter the liquid reservoir is raised, and its contents "immerse" the electrodes. A ratchet arrangement prevents disconnection being made until the battery is out of use. By this arrangement, requiring the use of one hand only, an accurate regulation of the electrodes can be obtained. Further, it is easy, when using ordinary bichromate solution, to raise or lower the liquid reservoir from time to time while the battery is in use, and so displace the gas which gathers upon the surface of the electrodes in consequence of their polarisation.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mrs. Cooper; an Erxleben's Monkey (*Cercopithecus erxlebeni*) from West Africa, presented by Miss Peers; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Lady Kensington; a Rendall's Guinea-fowl (*Numida rendalli*) from West Africa, presented by Mr. F. Le Sueur; three Razorbills (*Alca torda*), eight Puffins (*Fratercula arctica*) from Ireland, presented by the Rev. Ed. Weldon; a Long-eared Owl (*Asio otus*), European, presented by Mr. F. Allen; three Angulated Tortoises (*Chersina angulata*), an Areolated Tortoise (*Homopus areolatus*) from South Africa, a Black Sternothere (*Sternothærus niger*) from West Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two King Vultures (*Gypagus papa*) from Tropical America, deposited; an Axis Deer (*Cervus axis* ♂), a Duyker-bok (*Cephalophus mergens* ♂), born in the Gardens.

## OUR ASTRONOMICAL COLUMN

THE ASTRONOMISCHE GESELLSCHAFT. — The first and second parts of the twentieth year of the *Vierteljahrschrift*, issued by this Society, have been published as a single number. It contains reports from some thirty of the Continental observatories, detailing the astronomical work accomplished during the year 1884, and a Report from the Bureau of Calculation at Berlin, on the part of the Transit of Venus Commission, describing the progress made in the reduction of the observations of the transit of 1882. Dr. B. A. Gould, with the authority of the Government of the Argentine Republic, has offered the stereotype plates of the Catalogue formed from the Cordoba zones, to the Society, the gift carrying with it the sanction of the Government to a new edition being printed therefrom at such time as may be desirable. All the errors detected up to the time of Dr. Gould's communication have been corrected on the plates. It is almost needless to add that this valuable gift has been accepted by the Society, who will preserve the collection of plates at Leipsic.—The death is announced of Dr. T. Clausen, late director of the Observatory of Dorpat; amongst many other important contributions to astronomical science, his masterly discussion of the observations of Lexell's comet of 1770 will be remembered; his prize-memoir thereupon published in the *Astronomische Nachrichten* elicited from Bessel the eulogising remark—"Welche herrliche, oder richtiger, meisterhafte Arbeit ist die von Clausen über den Cometen von 1770; sie ist eine Leistung unsere Zeit, welche unsere Nachkommen ihr anzurechnen nicht vergessen werden."

The next meeting of this Society will be held at Geneva, from August 19 to 22, under the presidency of Prof. Auwers.

THE NEW COMET.—Mr. Barnard of Nashville, U.S., having notified his discovery of a small telescopic comet, on July 7, to Prof. Pickering, it was observed at Harvard College on July 9, the resulting position being—

July 9, 12h 33m 0s M.T.; R.A. 17h 17m 48s·4; Decl. −6° 1′ 8″

Prof. Millosevich communicates the following observations made at the Collegio Romano, in Rome:—

July 12, 9h 56m 29s; Rome M.T.; R.A. 17h 12m 52s·35;

Decl. − 7° 32′ 15″·6.

He remarks that the comet had a nucleus 11m. in the preceding part of the small nebulosity.

The elements of the comet's orbit are yet uncertain, from the case not being a favourable one for calculation. The Dun Echt Circular of July 16 has an orbit computed by Mr. Chandler from observations between July 9 and 11; the resulting date of perihelion passage is May 16. But on combining the above observations on July 9 and 12 with one on July 15, made by Col. Tupman at Harrow, it would appear that the comet may not arrive at perihelion till September. In this uncertainty we defer printing elements till next week. In any case the comet can hardly be one possessing much interest. The theoretical intensity of light seems to be decreasing.

TUTTLE'S COMET.—At the time of writing, no ephemeris to facilitate the re-observation of this comet at its approaching perihelion passage has, to our knowledge, been published, beyond the few positions which have been given in this column, on the assumption that the perturbations during the actual revolution have not been very sensible. If it should prove that no computation of the perturbations has been effected, it will be desirable to make a close examination of the north-eastern heavens during the absence of the moon in August, and just before morning twilight. The period of revolution of this comet at its last perihelion passage in December 1871, was 5045 days, which, without perturbation, would indicate September 24 as near the date of next perihelion passage.

## *ASTRONOMICAL PHENOMENA FOR THE WEEK*, 1885, *JULY* 26 *TO AUGUST* 1

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

*At Greenwich on July* 26

Sun rises, 4h. 17m.; souths, 12h. 6m. 14·3s.; sets, 19h. 55m.; decl. on meridian, 19° 22′ N.: Sidereal Time at Sunset, 16h. 14m.

Moon (Full on July 27) rises, 19h. 15m.; souths, 23h. 58m.; sets, 4h. 46m.*; decl. on meridian, 15° 30′ S.

| Planet | Rises h. m. | Souths h. m. | Sets h. m. | Decl. on meridian ° ′ |
|---|---|---|---|---|
| Mercury ... | 6 39 ... | 13 46 ... | 20 53 ... | 12 10 N. |
| Venus ... | 6 18 ... | 13 37 ... | 20 56 ... | 14 19 N. |
| Mars ... | 1 8 ... | 9 26 ... | 17 44 ... | 23 41 N. |
| Jupiter ... | 7 25 ... | 14 19 ... | 21 13 ... | 9 52 N. |
| Saturn ... | 1 44 ... | 9 54 ... | 18 4 ... | 22 31 N. |

* Indicates that the setting is that of the following day.

*Phenomena of Jupiter's Satellites*

| July | h. m. | | July | h. m. | |
|---|---|---|---|---|---|
| 29 ... | 20 57 | II. tr. ing. | 31 ... | 19 49 | II. ecl. reap. |
| 30 ... | 20 9 | I. occ. disap. | | | |

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

| July | h. | |
|---|---|---|
| 26 ... | 7 ... | Mercury in conjunction with and 0° 12′ south of Regulus. |

## *GEOGRAPHICAL NOTES*

The Rev. G. Grenfell has recently explored the Mobangi, which enters the right bank of the Congo, forming a great delta, between 26′ and 42′ S. lat., nearly opposite Equator Station, and is probably its greatest tributary. Mr. Grenfell navigated the Mobangi in the little steamer *Peace*, on a mean course of north by east, from the equator to 4° 30′ N. lat., and left it still an open waterway. At 4° 23′ N., just below the second rapids, he found it 673 yards wide; at no point lower was it less in width. Its mean depth is 25 feet, and although the current runs not more than 80 to 100 feet per minute, it means an immense volume of water to find running south at a point, as Mr. Grenfell puts it, so near the supposed sources of the Binné, the great affluent of the Niger. Where does it all comes from? he asks. The "trumbashes" of the Chad Basin (Schweinfurth) are common, while they are not known on the Congo. The opinion of Mr. Grenfell and of his Congo colleagues, we believe, is that the Mobangi is probably the lower part of the Welle, a river whose course is one of the unsolved problems of African geography. This is certainly a more likely solution than to connect the Welle with the useless Aruwimi, as Stanley is inclined to do. From the notes sent home by Mr. Grenfell, it would seem that the Mobangi is navigable the whole way from the Congo to 4° 30′ N., a distance of probably 400 to 450 miles, taking account of the bends. A large map, in ten sheets, of the explored part of the river has just been received at the Royal Geographical Society. It is hoped that a full narrative of Mr. Grenfell's explorations will reach England in time to be read at the Aberdeen meeting of the British Association. The Mobangi, Mr. Grenfell writes, is far more populous than any equal length of the Congo, and to his mind the country is more promising. Whether the Mobangi is the Welle or not, it must form an important connecting link between the basin of the Congo and the basins of the Niger, the Shari, and the Nile. Mr. Stanley has always maintained that the region lying between the Congo and the Nile is probably the richest and most promising in Africa, and his belief seems likely to be amply confirmed. Besides the Mobangi, Mr. Grenfell has explored 300 miles of river courses debouching into the Congo, and, as he is a trained and careful surveyor, he will be able to plot them with precision. The most northerly point of the Congo bend he found to be 2° 11′ N. lat., near the mouth of the Ukere or Dujangi.

At the last meeting of the French Geographical Society, held on Friday night, M. Ferdinand de Lesseps gave an account of the recent success of the operations conducted with the object of finding water in the desert tracts of Southern Tunis. After the death of Col. Roudaire the French Minister of War authorised Commandant Landais to resign his duties at the Military School at Saint Cyr, in order that he might continue the schemes set on foot in the region of the Tunisian Shotts. At this time those who believed in the success of these undertakings directed their attention chiefly to the establishment of a harbour at Gabes. The necessity for a port where vessels could put in on the southern coast, and for a town through which the traffic of Tunis and Tripoli could be conducted, was apparent. It was determined to commence operations at the mouth of the Wady Melah, and to make the station established at this point the basis of future and more extensive operations. Two years ago M. de Lesseps, in company with M. Roudaire, visited the region of the Shotts. They observed there, on the banks of the Wady Melah, a lake in which the level of the water never sinks. This water was excellent. M. de Lesseps thought, although there was no visible confirmation of the fact, that this water might be in communication with a deep sheet of water. In consequence he requested the engineers to make borings, or to sink a well at that spot. They have succeeded admirably. At a depth of 91 metres they reached the sheet of water sought for. The flood rushed from the ground with such velocity that it raised with it stones weighing 12 kilogrammes, and threw them to a great height into the air. The well yields 8000 cubic metres of water a minute.

## *ANNUAL REPORT OF THE FISHERY BOARD FOR SCOTLAND*, 1884

The third Report of the New Fishery Board for Scotland, which was recently presented to Parliament, contains, amongst other useful information, valuable statistics of the fish captured during 1884, and a record of the scientific work carried on under the direction of Prof. Ewart, the energetic convener of the Scientific Committee of the Board. From the Report it appears that the herring fishing of 1884 was the most abundant ever known. Unfortunately, it was largely composed of immature and small fish, and consequently it was of much less value than it would otherwise have been. Great shoals of young herrings were found far out at sea much earlier than usual, and heavy takes were made before they had time to mature. The curers were often unable to overtake the hauls of mature fish, and hence much good food was wasted. The haddock and sprat fishings were also successful, and large quantities of halibuts were taken off Shetland. The salmon fishing was not so productive as in 1883, which was a singularly good year. The most important fish taken and sold fresh is the haddock, of which the value is nearly three times as great as any of the others. The total estimated value of the white fish amounted to 716,295*l.*, and of the shell-fish, 80,939*l.* Beam trawling was carried on to a much greater extent than formerly, and with a fair amount of success. Telegraphic communication has been extended to the fishery stations at Castle Bay, Island of Barra, St. Mary's Burra, St. Margaret Hope, Orkney, Reawick, and Vaila Sound (Walls), Shetland, and this is much appreciated by the fishermen and other persons engaged in the fishing industry. Several harbours have also received grants to aid in construction or improvement. The Board, having recognised that great progress had been made in practical fish-culture in America, requested Prof. Cossar Ewart to visit Canada and the United States and report on the methods adopted there for improving the fisheries. Prof. Ewart accordingly visited first the fish-hatching stations in Canada, and afterwards the principal fishing-stations and laboratories of the United States Fish Commission. In addition to visiting the central station and the carp ponds in Washington, Prof. Ewart was able to study the appliances for carrying on hatching and other operations at Wood's Holl. He also visited the Bucksport and other stations for hatching salmon and trout, studied the arrangements for receiving and preserving fresh fish at Gloucester, Boston, and New York, and the methods of utilising the by-products of the fisheries. He likewise examined the boats and fishing appliances in use among the American fishermen and also the splendid vessel *Albatross*, recently constructed for the scientific work of the Fish Commission. It seems the Commission considers that "the best policy is to expend a small amount of public money in making fish so abundant by artificial means that they can be got without restriction and serve as cheap food for the people at large, rather than to expend a much larger amount in trying to prevent people from catching the few which remain after years of improvidence." In order to carry on investigations and hatching operations on the lines which have proved so successful in America, the Board will require to be provided with (1) a well-equipped laboratory with

suitable hatching-tanks and at least one large sea-water pond; (2) a cruiser adapted for carrying on dredging and other operations; (3) two small steam tenders adapted for inshore work; (4) a sufficient annual sum of money to meet the working expenses of hatching and other operations and to provide the necessary apparatus. From information gained in America the Board feels that, if provided with sufficient funds and with increased powers, it might be able greatly to increase the number of useful food fishes in the firths, bays, and other waters around the coast. The marine station at St. Andrews is now in working order and an assistant naturalist has been sent to carry on investigations under the direction of Prof. McIntosh, F.R.S. A number of interesting inquiries have been instituted, especially on the nature of the eggs and rate of growth of fishes and the life-history of the common mussel. The Scientific Committee, who felt the assistance of an experienced naturalist devoting his whole time to the work of inquiry to be not merely expedient but necessary, have been so fortunate as to secure the services of Mr. Brook, F.L.S., of Huddersfield, who had been studying for some time the history and habits of fish, and gained considerable experience in organising and carrying on a marine laboratory. A temporary laboratory has been erected at East Tarbert, a convenient situation for studying the west coast fishing and from which it is possible to study not only the herring-fishing in Loch Fyne, but, with a good steamboat, to embrace the whole area of the Firth of Clyde. Mr. Brook is engaged in studying the development of the herring, and the result of his experiments will be described in detail in papers the first of which is now appended—the others to be presented to the Board in the autumn. Mr. Brook has also in hand a paper on the "Food of the Herring," to be completed in the autumn. The Directors of the Rothesay Aquarium have very kindly placed the tanks of their institution at the service of the Board, and this will be of great assistance in the study of the life-history of various food fishes, especially during the winter months. There is now at the service of the Board a small laboratory in the Cromarty Firth, and it is hoped that a marine laboratory may soon be established near the mouth of the Firth of Forth.

The most important paper in the scientific appendices contains "Observations on the Spawning of the Cod," by Prof. Cossar Ewart and Mr. George Brook. The authors say that it is now twenty years since G. O. Sars discovered, what our fishermen still decline to believe, that the eggs of the cod float on the surface of the sea, and only sink when dead. Sars's after-investigations showed that the eggs and the milt are of less specific gravity than the sea water, and consequently float, also that the micropyle lies near the lower portion of the egg. The experiments reported were carried on in Rothesay Aquarium on fish which had been in the tanks for four years. In February several cod appeared to be reaching maturity; early in March the fish refused food, and a few days afterwards eggs in an early stage of development were floating on the surface of the water, so abundantly that hundreds were collected in a few minutes by means of a piece of muslin placed over the overflow of the tanks. The temperature of the water was 43° F., and the specific gravity a little over 1·024. The eggs were usually found during the first few days in from the 2- to 8-cell stage at 8 a.m., so that they were most probably shed about daybreak. Later batches shed between 6 and 7.30 p.m. were found at the latter hour with the disk already forming. The great transparency of the living eggs makes it almost impossible to notice them as they rise through the water, whilst the dead eggs, being slightly opaque, are easily recognised as they are carried to and fro by the currents. For some time before the first eggs reach maturity, and during the early part of the spawning period, the fish not only refuse food, but give up their regular movements around the tank and swim about in small groups or rest together at the bottom, swimming and resting alternately. Sometimes a single female would swim leisurely about for a few minutes attended by a single male, and often settle down in a corner of the tank and rest till disturbed by her attendant. The activity of the males was specially evident at dusk and in the early morning, and it was apparently during these periods of activity that the eggs were shed and fertilised. One day, for example, there were no eggs visible on the surface of the water at 6 p.m., while a considerable number were obtained at 7.30, which, as the germinal disk was not completely formed, had in all probability been quite recently shed while the fish had been swimming about the tank in groups. From the observations made, it seems, as suggested by Sars, that the eggs and milt are shed while the fish are swimming freely about in the water. The males swim indiscriminately among the females, sometimes over, sometimes under them, fertilising the water through which the shed eggs are slowly rising to the surface. Eggs were pressed from a ripe female and fertilised artificially. They developed normally, but it was found that a few kept for some hours in a small glass cell in a warm room, for observation under the microscope, began to show similar abnormalities to those figured by Ryder ("Embryology of Osseous Fishes," Report U.S. Fish Commission, 1882). Too high a temperature has a similar effect on other eggs, but those which float on the surface are naturally more sensitive. The females, like the Salmonidæ, are capable of withholding the flow of ripe eggs to a certain extent. A limited number only are ripe at one time, and if the unripe be forced out they sink to the bottom and are incapable of being fertilised. The ripe unfertilised egg has a milky appearance and is moreover not so transparent as the fertilised one, so that by a little practice the two can be distinguished without the aid of a microscope. As soon as an egg begins to die or to develop abnormally, the milkiness returns and it sinks to the bottom. Whether fertilised or not, the eggs float immediately after extrusion, but in the latter case they die and sink to the bottom in twelve to fourteen hours. During this time no change was observed to take place in the unfertilised egg, the small oil-vesicles around the yolk remaining constantly in their primitive condition. In perfectly still water (sp. 1·024) the eggs float in a dense mass; when carried along by a strong current they become suspended at various depths, but none that are living lie at the bottom. At any rate all found there were either dead or dying. It seems that large numbers of the pelagic fish eggs have been dredged at the Fishery Board Station at Tarbet. With the sea perfectly calm, most eggs were obtained on the surface; with a slight ripple the net had to be kept just under the surface and in other states of the weather to be lowered two or three feet under the surface. The eggs having a specific gravity only slightly less than that of water, do not rise to the surface very rapidly. In one case noted it took an egg four minutes to rise through 1½ inches of water. The milt also has less specific gravity than sea-water, and rises to the surface when shed. If forced down, it gradually rises again, disseminating as it does so. During the spawning process the water in the tank became slightly clouded by the spermatazoa, which were spread through it. The milt is, however, shed in such a thin stream under natural conditions that it is difficult to detect it. The eggs are capable of being fertilised a considerable time after the fish is dead, and also some time after they have been shed. Light appears to have considerable influence on the spawning process, and under natural conditions the eggs seem to be shed at daybreak or dusk, when the light is not strong. The observations made justify the conclusion that the spawn is shed while the fishes are swimming about freely in the water, and that the eggs are fertilised at, or as they rise to the surface, this being facilitated by the position of the micropyle, which is always found in the lower hemisphere of pelagic fish ova. To show the facility with which some fish ova are fertilised, an experiment on herring ova may be here mentioned. Three batches of ova secured from a living female were placed in tumblers, and water added from an adjoining tank. It was intended to fertilise each batch separately, and at fixed intervals, but it was found that though no milt had been intentionally added to the second or third tumblers, the water not being from the tank in which the herring were kept, spermatozoa must have been introduced with the water, as the second and third batch of eggs developed exactly like the first, and were ultimately hatched out. As Kupfer points out, it is necessary, in order to keep eggs unfertilised, to get a fresh supply of water direct from the sea.

Mr. Brook's first paper on the "Development of the Herring" gives a *résumé* of what is already known on the subject, as preliminary to the result of his own investigations. He also sends notes of rare and curious fishes sent to the Board. Dr. M'Intosh details the work done by himself and by his scientific visitors to the St. Andrew's Laboratory. Prof. Cossar Ewart reports on the progress of Fish-culture in America, and Mr. Young on the Northern and Western Salmon Rivers. The Report is both interesting and encouraging. It is difficult to form an adequate idea of the immense importance of their sea-fisheries to the people of Scotland. But it may be stated that about half a million of people, or about one-seventh of the entire population of Scotland, are connected with this industry, and more or less

dependent upon it. Happily the country is now beginning to realise the importance of the matter, and when the Government places at the disposal of the Board sufficient money to carry on the necessary investigations, the produce of the Scottish fisheries, great as it now is, may be still largely increased.

## *RADIANT MATTER SPECTROSCOPY*

THE following paper on this subject was read by Mr. Crookes at the Royal Society, June 18:—

In the concluding sentence of the Bakerian lecture which I had the honour to deliver before the Royal Society, May 31, 1883, I said that the new method of radiant matter spectroscopy there described had given me not only spectrum indications of the presence of yttrium as an almost invariable, though very minute, constituent of a large number of minerals, but had likewise revealed signs of another spectrum-yielding element. I stated that I had repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band.

*Elimination of Mercury Vapour from Vacuum Tubes.*—It is much more difficult than is generally supposed to keep mercury vapour from diffusing into the experimental tubes.

The following plan answers perfectly so far as my experiments have yet gone:—Sulphur is first prepared by keeping it fused at a high temperature till bubbles cease to come off, so as to get rid of water and hydrogen compounds. It is then allowed to cool, and is pounded and sifted so as to get it in the form of granules averaging a millimetre in diameter. A glass tube, a centimetre in diameter and about 2 feet long, is lightly packed for half its length with this sulphur, and next about 2 inches of iodide of sulphur ($I_2S_2$) is added, and the rest of the tube is then filled up with sulphur. Ignited asbestos is packed in at each end to keep the sulphur from blowing out whilst the vacuum is being made, or from being sucked through when air is suddenly let in. This contrivance entirely keeps mercury vapour from passing through, since the iodide of sulphur holds its iodine very loosely, and fixes the mercury in the form of non-volatile red iodide. A glass tube containing finely-divided copper must follow in order to keep the sulphur out. With this blockade interposed between the pump and experimental tubes I have been unable to detect mercury vapour in any of the tubes, whether in the cold or on heating them.

*The "Orange Band" Spectrum.*—Since the date of my last paper I have devoted myself to the task of solving the problem presented by the double orange band first observed in 1881. With the yttrium experience as a guide it might be thought that this would not be a difficult task, but in truth it helped me little beyond increasing my confidence that the new, like the old spectrum, was characteristic of an element. The extreme sensitiveness of the test is a drawback rather than a help. To the inexperienced eye one part of "orange band" substance in ten thousand gives as good an indication as one part in ten, and by far the greater part of the chemical work undertaken in the hunt for the spectrum-forming element has been performed upon material which later knowledge shows does not contain sufficient to respond to any known chemical test.

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces;" and when an analysis adds up to 99·99, the odd 0·01 per cent. is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·99 per cent. constitutes the impurity and this exiguous 0·01 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood, is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and by the solubility of nearly all precipitates in water or in ammoniacal salts, when present in traces only. What is here meant by "traces" will be better understood if I give an instance. After six months' work I obtained the earth didymia in a state which most chemists would call absolutely pure, for it contained probably not more than one part of impurity in five hundred thousand parts of didymia. But this one part in half a million profoundly altered the character of didymia from a radiant matter spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another six months' extra labour to eliminate these final "traces," and to ascertain the real reaction of didymia pure and simple.

*Chemistry of the Orange Band-forming Substance.*—At first it was necessary to take stock, as it were, of all the facts regarding the supposed new substance, provisionally termed *x*, which had turned up during the search for the orange band. In the first place *x* is almost as widely distributed as yttria, frequently occurring with the latter earth. It is almost certainly one of the earthy metals, as it occurs in the insoluble oxalates, in the insoluble double sulphates, and in the precipitate with ammonia. It is not precipitated by sodic thiosulphate, and moreover it must be present in very minute quantities, since the ammonia precipitate is always extremely small, and as a rule *x* is not found in the filtrate from this precipitate.

At this stage of the inquiry the chemical reactions of *x* were much more puzzling than with yttria. At the outset an anomaly presented itself. The orange band was prone to vanish in a puzzling manner. Frequently an accumulation of precipitates tolerably rich in *x* was worked up for purposes of concentration, when the spectrum reaction suddenly disappeared, showing itself neither in precipitate or filtrate; whilst on other occasions, when following apparently the same procedure, the orange band became intensified and concentrated with no apparent loss. The behaviour of the sulphate to water was also very contradictory; on some occasions it appeared to be almost insoluble, whilst occasionally it dissolved in water readily.

*Is "x" a Mixture?*—A very large series of experiments, which need not here be described in detail, resulted ultimately in establishing the remarkable fact that the *x* I sought was an earth which of itself could give no phosphorescent spectrum in the radiant matter tube, but became immediately endowed with this property by admixture with some other substance, which substance likewise by itself had no power of phosphorescing with a discontinuous spectrum.

*"x" in Cerite.*—In the corresponding yttrium research I was aided materially by the fact that the sought for earth did not give an absorption spectrum. This enabled me to throw out a large number of obscurely known elements, and I therefore early endeavoured to ascertain whether the supposed new earth, *x*, did or did not give an absorption spectrum. Gradually it was noticed that whenever the didymium absorption bands were strong, the orange band spectrum was also particularly brilliant. Moreover, amongst the earths previously enumerated as mixed with lime in the quest for *x*, I have mentioned that some of them gave the orange band spectrum with increased intensity; the earths of the cerium group were the most noteworthy, and these considerations made it probable that here would be found the location of *x*.

*Analysis of Cerite.*—The cerium group consists of cerium, lanthanum, didymium, and samarium.

The first necessity was to get the earths ceria, lanthana, and the mixture hitherto called didymia, in a pure state; for my so-called pure earths of this group all showed the orange band in more or less degree.

The separation from each other of ceria, lanthana, didymia, and samaria is a most laborious process, and the amounts of these earths, obtainable in anything like a pure state, is small, compared with the mass of material worked up. Full particulars are given in the paper as to the method adopted to obtain each of them in a state of purity.

*Ceria.*—The ceric oxide obtained was almost pure white. A considerable thickness of a strong solution did not show a trace of absorption spectrum. The atomic weight of the metal was taken and yielded the number 141·1.

The ceric oxide gave no orange band spectrum in the radiant matter tube, either with or without the addition of lime.

*Lanthana.*—Lanthana is more difficult to purify than ceria. Long after the lanthana appeared pure it gave in the radiant matter tube a good orange band spectrum when mixed with lime and treated as usual, although without lime it gave no spectrum. Ultimately, however, a lanthana was obtained which, mixed with lime and treated in the usual manner, gave no orange band spectrum whatever. This lanthana was snow-white, and had an atomic weight of 138·3.

*Didymia.*—The earth formerly called didymia is now known to be a mixture of didymia and samaria, and systematic operations were now commenced with the object of obtaining the didymia and the samaria in a state of purity—that is to say, in such a condition that one of them should show no orange band

spectrum at all, whilst the other should give the spectrum in its highest degree of intensity.

I commenced the purification of didymia in the latter part of the year 1883, and the operations have been going on since almost daily in my laboratory. At intervals of some weeks the didymia in the then stage of purification was tested in the radiant matter tube, a little lime having previously been added to bring out the discontinuous phosphorescence. During the first month or two the intensity of the orange band spectrum scarcely diminished. After this it began to fade, but the last traces of orange band were very stubborn, and not till the last few weeks could I obtain a didymia to show no trace of the orange band spectrum; and this result has not been accomplished without sacrifice. My 1000 grammes have dwindled away bit by bit, till now less than half a gramme represents all my store.

*Samaria.*—The foregoing experiments left little doubt that $x$, the orange-band-forming body, was samarium; the last problem was, therefore, to get this earth in a pure state. The general plan of operations was the same as I adopted in getting didymium free from samarium, only attention was now directed to the portions richest in samarium which had been formerly set aside. The colour of samaria, as pure as I have been able to prepare it, is white with the faintest possible tinge of yellow. The absorption spectrum of samarium salts is much more feeble than the spectrum of didymium.

*The Phosphorescent Spectrum of Samarium.*—Pure samaric sulphate by itself gives a very feeble phosphorescent spectrum. When, however, the samaria is mixed with lime before examination in the radiant matter tube, the spectrum is, if anything, more beautiful than that of yttrium. The bands are not so numerous, but the contrasts are sharper. Examined with a somewhat broad slit, and disregarding the fainter bands, which require care to bring them out, the spectrum is seen to consist of three bright bands—red, orange, and green—nearly equidistant, the orange being the brightest. With a narrower slit the orange and green bands are seen to be double, and on closer examination faint wings are seen, like shadows to the orange and green bands.

Preliminary experiments had shown me that lime was one of the best materials to mix with samaria in order to bring out its phosphorescent spectrum, but it was by no means the only body which would have the desired effect.

The samarium spectra, modified by other metals, may be divided into three groups. The first group comprises the spectra given when glucinum, magnesium, zinc, cadmium, lanthanum, bismuth, or antimony is mixed with the samarium. It consists simply of three coloured bands—red, orange, and green; as a typical illustration I will select the lanthanum-samarium spectra (Fig. 1).

The second type of spectrum gives a single red and orange and a double green band. This is produced when barium, strontium, thorium, or lead are mixed with samarium. The lead-samarium spectrum (Fig. 2) illustrates this type.

The third kind of spectrum is given by calcium mixed with samarium. Here the red and green are single, and the orange double. Aluminium would also fall into this class were it not that the broad, ill-defined green band is also doubled. The calcium-samarium spectrum (Fig. 3) is a good illustration of this type.

*Mixed Samarium and Yttrium Spectra.*—It was interesting to ascertain what spectrum a mixture of samarium and yttrium would give. A mixture of 90 parts of samaria to 10 of yttria was treated with sulphuric acid and then ignited, and afterwards examined in the radiant matter tube. The result was as remarkable as it was unexpected. Not a trace of the yttrium spectrum could be detected. The powder phosphoresced with moderate intensity, but the spectrum was almost the facsimile of that given by pure samaric sulphate, except that the sharp orange line, which in the spectrum of pure samaric sulphate is only just visible, had gained sufficiently in intensity to be measurable, and was found to lie at 2693, on the $\frac{1}{\lambda^2}$ scale. A large number of experiments were next tried on mixtures of samaria and yttria in different proportions, and the results are given in full in the paper.

Up to mixtures of 43 parts samaria and 57 parts yttria the spectrum nearly resembled the lead-samarium spectrum. Not a band of the yttria spectrum could be detected, and the brilliant orange line stood out sharply in the whole series. This spectrum is represented in Fig. 4.

After that proportion had been reached a change rapidly came over the spectra, and in the next trial mixture—samaria 35, yttria 65—the only indication of the samarium spectrum that could now be found was seen in the two faint green bands next to the citron line of yttria, and the new orange line, which shone out as brightly and sharply as ever.

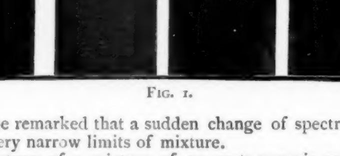


FIG. 1.

It will be remarked that a sudden change of spectrum occurs between very narrow limits of mixture.

The spectrum of a mixture of 44 parts samaria and 56 parts yttria, except for the orange line, is the pure samarium spectrum. The spectrum of 42 samaria and 58 yttria is built up of some of the component bands of the spectrum of each earth; whilst the

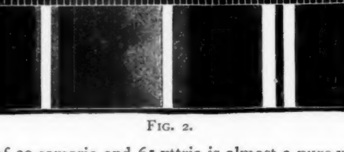


FIG. 2.

spectrum of 39 samaria and 61 yttria is almost a pure yttria spectrum, the sharp orange line running across them all.

*The Delicacy of the Spectrum Test for Samarium.*—Experiments were now commenced with the object of getting some approach to a quantitative estimate of how small a quantity of samarium could be detected.

A mixture was first made in the proportion of 1 part sama-

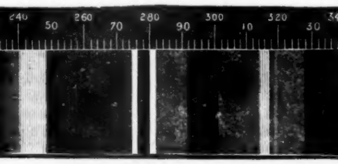


FIG. 3.

rium to 100 parts of calcium. The spectrum is very brilliant, and but little inferior in sharpness to the spectrum given by a 50 per cent. mixture.

A mixture was now prepared containing 1 part of samarium to 1000 parts of calcium. Very little difference can be detected between the spectrum of this mixture and that of the last. The bands are, however, a little less sharp.

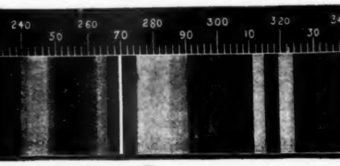


FIG. 4.

A mixture containing 1 part of samarium to 10,000 parts of calcium was now tested. The bands are now getting fainter, the second green band is fading out, and the continuous spectrum of calcic sulphate is getting brighter.

The next mixture tried contained one part of samarium in 100,000 parts of calcium. Here the green is almost gone, being overshadowed by the continuous spectrum of calcium which has

spread over it. The red band has likewise almost disappeared in the greater brightness of the continuous red of the calcic spectrum. The double orange band is still very prominent, and the black space, 2942, between it and the green is very marked.

The next mixture, one part of samarium to 500,000 parts of calcium, gives a spectrum which is fainter than the last, but the orange bands are still distinctly visible. The blank space between the yellow and green is strongly marked, but narrower than before.

A mixture of one part of samarium in 1,000,000 parts of calcium was next subjected to experiment. In this the samarium spectrum is very feeble, and the orange bands are only to be seen with difficulty. Now the most striking characteristic of this spectrum is the black space which still cuts out the greater portion of the yellow.

A mixture of one of samarium in 2,500,000 parts of calcium was now taken. In the spectrum shown by this mixture the bands of samarium have entirely gone, and its presence now is apparent only by the darkening in the yellow portion of what otherwise would be a continuous spectrum.

The calcium phosphorescent spectrum by itself is continuous, with no break, lines, or bands in it.

*The Anomalous Line* $\frac{1}{\lambda^2}$ 2693.—On several occasions I have spoken of an orange line, 2693, which by its brilliancy and sharpness is a prominent object in most of the samarium-yttrium spectra. With pure samaric sulphate it is exceeding faint. With samaria containing 5 per cent. of yttria it is very little brighter; with 10 per cent of yttria it gains a little; with 15 per cent. it is brighter still, and with a mixture of 80 parts samaria and 20 parts yttria it is at its maximum intensity. It continues to be the most striking feature in the spectra of the various mixtures of samaria and yttria until the proportion becomes samaria 3, yttria 97, when it begins to get less bright, and only when pure yttria is reached does it altogether vanish.

It is noteworthy that so long as this bright line is a component of the spectrum, the other bands manifest decidedly less intensity, and many of them are suppressed. The profound modification in the spectra of samaria and yttria developed by their mixture is, I believe, without precedent in spectrum analysis. It is difficult to realise the character of the modification which converts somewhat faint diffused bands into one intensely sharp and brilliant line.

One important lesson taught by the many anomalies unearthed in these researches is that inferences drawn from spectrum analysis *per se* are liable to grave doubt, unless at every step the spectroscopist goes hand in hand with the chemist. Spectroscopy may give valuable indications, but chemistry must after all be the court of final appeal.

The following paper (reprinted from the *Chemical News*) is so intimately connected with Mr. Crookes's work, that it may be appropriately appended to his paper:—

At the meeting of the Académie des Sciences on June 8, 1885, M. Lecoq de Boisbaudran requested that a sealed packet which he had deposited June 30, 1884, might be opened. The packet was opened by the Permanent Secretary during the meeting, and contained the following note:—

"When the electric spectrum of a solution *with a metallic base* is produced it is customary to make the outside platinum wire (whence the induction spark strikes) positive, the liquid consequently forming the negative pole.[1] If the direction of the current is reversed, the metallic rays (due to the free metal or to one of its compounds) are scarcely or not at all visible, at at all events so long as the exterior platinum wire now forming the negative pole is not coated with a deposit.

"Having again last year taken up my researches on the rare earths belonging to the didymium and yttrium family, I had occasion to observe with many of my preparations the formation of spectrum bands, nebulous, but sometimes tolerably brilliant, having their origin in a thin layer of a beautiful green colour, which was seen to appear at the surface of the liquid (a solution of a chloride) when it was rendered *positive*.

"These are the approximate positions of the principal bands:—

[1] This rule, hitherto general for *metallic* solutions, is not always applicable to liquids containing *metalloid* bodies, as I have already had occasion to notify (see my "Spectres Lumineux," p. 38).

| Micrometer | | λ | Observations |
|---|---|---|---|
| $91\frac{3}{4}$ | About the middle. | $620\frac{1}{2}$ | A narrow band, somewhat hazy. Rather faint. About $1\frac{1}{2}$ divisions wide. (Due to calcium??) |
| 101 | Approximately about the middle. | $585\frac{3}{4}$ | A nebulous band slightly connected with the following one. About 3 divisions wide. Slight intensity, but generally stronger than $91\frac{3}{4}$. |
| $104\frac{9}{10}$ | Approximately about the middle. | 573 | A nebulous band. Intensity varying with the state of the liquid and strength of spark. It seems to be fainter in the earths obtained from the sulphates which are very slightly soluble in potassic sulphate than in the earths obtained from the more soluble double sulphates. In some cases it has been seen as brilliant as α $115\frac{1}{3}$, but it has almost always been seen *much* more feeble than $115\frac{1}{3}$ in the earth obtained from the very slightly soluble double sulphate. It has, indeed, on several occasions been seen fainter than 101. |
| From $111\frac{1}{2}$ to 112 | About the beginning. Very indistinct. | | A nebulous band, shading off from right to left. Rather strong, and generally much the most brilliant in the spectrum of the yellow earth whose double potassic sulphate is very slightly soluble. |
| $115\frac{1}{3}$ | About the middle of maximum of light. | $543\frac{1}{3}$ | |
| 117 | About the end. Very indistinct. | | |
| About $141\frac{1}{5}$ | Apparent centre. | 487 | A very hazy band, appearing somewhat shaded from right to left when the spectrum is brilliant. About 4 or $4\frac{1}{2}$ divisions wide. Somewhat joined to the following. Generally of very moderate intensity. |
| About $147\frac{1}{3}$ to $147\frac{1}{2}$ | Apparent centre. | $476\frac{1}{2}$ | Faint band, very hazy. About 6 divisions wide. |

"On comparing in the different products the relative intensities of this new reversion spectrum and of the already known direct rays, I have come to the conclusion that the body producing the band α $115\frac{1}{2}$ is very probably *not* one of the following:—

"Didymium, erbium, Yα (of M. de Marignac), lanthanum, samarium, zirconium, scandium, thulium, ytterbium, yttrium.

"Cerium and thorium are also excluded for chemical reasons.

"I have not yet obtained the new spectrum with a substance altogether free from holmium, but I have good reasons to think that this metal is not the cause of the observed phenomena.

"The treatment undergone by the earths which give most sharply the reversion spectrum hardly admits in my preparations of the presence of such bodies as phosphoric, boric, &c., acids.

"The band α $115\frac{1}{3}$ (and most of the others which, except perhaps the band $104\frac{9}{10}$, follow in their intensities the same variations as α $115\frac{1}{3}$) appears, therefore, only to be attributable to terbia, unless, indeed, it be due to some new analogous earth not hitherto defined.[1]

"The treatment of a yellow earth obtained from samarskite, and much resembling that which is now called *terbia*, has already

[1] There remains to be examined the earth decipia (of M. Delafontaine), the existence of which appears to be confirmed by the researches of M. Clève.

given me interesting results, which, however, it will be difficult to describe in this short preliminary note. I will only say that all the bands specified above (except sometimes $104\frac{9}{10}$) are especially very marked in the earth which is most easily precipitated by ammonia, which has a sulphate least soluble in potassic sulphate, and whose chloride, very soluble in pure water, is difficultly soluble in concentrated hydrochloric acid.

"Shall we find two earths respectively characterised by the bands $104\frac{9}{10}$ and $\alpha$ $115\frac{1}{3}$?

"The production of my reversion spectrum appears to be analogous physically with the formation of the phosphorescence spectra obtained by Mr. Crookes at the positive pole in his high vacuum tubes containing certain compounds of yttria. The conditions of the two experiments are, however, very different practically speaking.

"It is a singular fact that the positions of the phosphorescence bands observed by Mr. Crookes with very pure compounds of yttrium, are sufficiently near those which I, on my part, have obtained with hydrochloric solutions of the earths separated as widely as possible from yttria, chemically as well as spectroscopically. My reversion spectrum cannot, I think, be attributed to yttrium, for on the one hand it is seen *brilliantly* with products which give no trace of yttrium rays by the direct spark, and on the other hand I have found it impossible to obtain it sharply from certain earths extremely rich in yttria.

"As soon as my work is sufficiently advanced to enable me to arrive at some definite conclusion, I shall have the honour of informing the Academy of it."

M. Lecoq de Boisbaudran added the following additional note:—

I have not yet finished the very long work undertaken in the hope of determining the nature of the above described phosphorescence spectrum.

This spectrum is now recognised as being identical with that which is ascribed to pure yttria by Mr. Crookes, and which this *savant* obtained under experimental conditions very different to mine. Nevertheless my latest observations, as well as the older ones, lead to the conclusion that yttria is not the cause of the spectrum bands observed. In my fractionations the phosphorescence spectrum regularly gets weaker as I advance towards the yttria end. With almost pure yttria the phosphorescence bands show themselves faintly or not at all, whilst they are brilliant with the earths which do not give by the direct spark the rays of yttrium to an appreciable extent.

The prodigious sensibility of Mr. Crookes's reaction, which detects a millionth part of his purified yttria, makes very singular this divergence which I am obliged to point out between the conclusions of the eminent English chemist and myself. Mr. Crookes has willingly undertaken to examine some of my products in his high-vacuum tubes; and, on the other hand, he has promised to send me the earths prepared by himself, so that I can examine them by my process. A comparison of these cross experiments, it is hoped, will throw some light on the question of the origin of the phosphorescence spectrum.

Another conclusion from my researches, a conclusion which I publish with a certain reserve because my work is not yet finished, is that the bands 105 and 115 do not belong to the same element. On this hypothesis, based on the fact that some of my products give 105 notably stronger than 115, whilst others show 115 brightly and 105 faintly, I will provisionally call $Z\alpha$ the earth characterised by 105, and $Z\beta$ the earth giving 115.

Space does not allow me to describe to-day the principal experiments or observations undertaken to find out what are $Z\alpha$ and $Z\beta$; this will form the subject of another memoir.

I should acknowledge here that Mr. Crookes was the first to see the phosphorescence spectrum of samarium. During the past year only this spectrum was pointed out to me by my learned friend M. Demarçay, to whom I had confided the secret of my method for the production of phosphorescence spectra by the reversion of the induced current. I then made a drawing of it.—*Comptes Rendus*, vol. c. p. 1437, June 8, 1885.

## SOCIETIES AND ACADEMIES

### LONDON

**Chemical Society**, June 18.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. Jos. F. Burnett and Harry M. Freear were formally admitted Fellows of the Society.—The following gentlemen were duly elected Fellows of the Society:—Messrs. Harry Haslett, Thomas Cradock Hepworth, Leonard de Koningh, Charles Langer, Arthur Richardson, James Sharp, James Pender Smith, James Spilsbury.—The following papers were read:—On the decomposition and genesis of hydrocarbons at high temperatures: I., the products of the manufacture of gas from petroleum, by Henry E. Armstrong and A. K. Miller, Ph.D. Having carried the examination of the various products of the decomposition of petroleum effected at high temperatures, in the manufacture of oil-gas (see paper in the *Journal* of the Society of Chemical Industry, September, 1884), as far as can usefully be done with the material originally dealt with, the authors now describe their methods and results; they remark, however, that these must be regarded as little more than preliminary, and that it will be necessary to repeat the investigation on a much larger scale, and to introduce new and improved methods. The products examined are (1) the portion of the compressed gas which combines with bromine; (2) the liquid deposited during compression of the gas to about ten atmospheres; (3) the portion of the tar which is volatile in steam. (1) By far the chief constituents of the mixture of bromides obtained by scrubbing the compressed gas by bromine are ethylene bromide and crotonylene tetrabromide, $C_4H_6Br_4$; propylene and butylene bromides have also been separated from it. The gas is practically free from hydrocarbons of the acetylene series capable of producing a precipitate in an ammoniacal cuprous solution. (2) The liquid deposited during compression of the gas is a complex mixture of olefines, of hydrocarbons of the $C_nH_{2n-2}$ series, and of benzenes. The presence in it of *normal* amylene, hexylene, and heptylene has been demonstrated by the study of the products of oxidation of the various fractions. It is saturated with crotonylene, and contains a considerable quantity of the next homologue, $C_5H_8$; this latter hydrocarbon has not been previously described; it boils at 45°, and yields a tetrabromide which crystallises from alcohol in long flat prisms melting at 114°. All attempts to separate a hydrocarbon having the properties of Schorlemmer's hexoylene from the fraction boiling at 80°–82° have hitherto been unsuccessful, the statement previously made by one of the authors that this hydrocarbon was present having been based on determinations which have since been discovered to be faulty. The liquid deposited during compression of oil-gas is rich in benzene and toluene, but contains only traces of higher benzenes. (3) The steam distillate from the tar contains the less volatile hydrocarbons present in the liquid deposited during compression of the gas, together with a great variety of others. It is rich in hydrocarbons which are readily polymerised by sulphuric acid; these appear to be mainly members of the $C_nH_{2n-2}$ series, such as Schorlemmer discovered in the light oils from cannel and boghead coal, and which yield no acid higher than acetic on oxidation. The three xylenes and mesitylene and pseudocumene are present in about the same relative proportions as in ordinary coal-tar; but in addition, the oil-gas tar contains certainly one—probably two—*higher* members of the benzene series: the amount obtained has not been sufficient, however, to permit of the precise determination of its nature. A very considerable amount of naphthalene may be separated from the tar; benzenoid hydrocarbons of higher boiling point than napthalene have also been obtained in small quantity. A certain, although relatively small, amount of a complex mixture of saturated hydrocarbons has also been separated from the tar: the quantity of material at their disposal has not enabled the authors to separate these to their satisfaction, and in a state sufficiently approaching purity; they are inclined to believe, however, that the mixture does not consist of paraffins, but of hydrocarbons of the $C_nH_{2n}$ series—such as form the chief constituents of Russian petroleum. The hydrocarbons mentioned are by no means the sole constituents of the material examined, but merely those which have been proved to be present. The theoretical conclusions to be deduced from the results are in some respects interesting. It would appear that *only normal* olefines are present, and it is also remarkable that apparently this series is not represented by terms higher than heptylene. No true acetylenes have been detected; the crotonylene obtained is either *methylallene*, $CH_3{\cdot}CH{\cdot}C{\cdot}CH_2$, or *dimethylene-ethane*, $C_2H_2(CH_2)_2$, and from their behaviour on oxidation it is probable that the homologous hydrocarbons are closely related to it. Hence it may be inferred that in the formation of hydrocarbons of the $C_nH_{2n-2}$ series at high temperatures from normal olefines of the formula $C_nH_{2n}+_1{\cdot}CH{\cdot}CH_2$ two atoms of hydrogen are removed in such a way that the terminal $CH_3{\cdot}CH_2$ radicle in the formula becomes either

$CH_3 \cdot CH$ or $CH_2 \cdot CH$; although the production of acetic acid on oxidation of the hydrocarbons favours the former hypothesis, it is not safe to accept it until several of the hydrocarbons of the $C_nH_{2n-2}$ series have been isolated and more completely studied. The possibility that *saturated* hydrocarbons of the $C_nH_{2n}$ series are among the products is especially noteworthy, although it must not be forgotten that such hydrocarbons might have been original constituents of the petroleum used in making gas. To settle this and other questions, it is proposed to prepare oil-gas from *solid* paraffin on a sufficient scale to obtain the quantity of material required for the investigation.—On the non-crystallisable products of the action of diastase upon starch, by Horace T. Brown and G. H. Morris, Ph.D.—Decomposition of carbonic acid gas by the electric spark, by H. B. Dixon, M.A., and H. F. Lowe, B.A. Various chemists have investigated the decomposition of carbonic acid by the electric spark. Experiments having shown that no explosion is propagated by a spark in a mixture of carbonic oxide and oxygen dried by standing over anhydrous phosphoric acid, it seemed of interest to repeat the experiments on the decomposition of carbonic acid when dried in a similar manner. Carbonic acid dried over anhydrous phosphoric acid was submitted to a series of induction sparks in an eudiometer by means of a chain composed of short pieces of platinum fused into small glass bulbs. The amount of decomposition varied from time to time, approaching no fixed limit. Similar results were found on introducing a Leyden jar into the secondary circuit of the Ruhmkorff, but the amount of decomposition was less. On passing a series of induction sparks through a dried mixture of carbonic oxide and oxygen, partial combination gradually took place, but no fixed limit was reached. Two similar eudiometers were prepared and fitted with wires made of an alloy of platinum and iridium, each wire ending in a bulb about 2 mm. in diameter. The bulbs were brought to the same distance apart in the two tubes. On bringing an equal volume of dried carbonic acid into the two tubes, and sending a series of sparks from one Ruhmkorff coil through both tubes at the same time, the gases in the two vessels were found to be equally affected, their volumes varying exactly together so long as the pressure was kept the same in the two tubes. The more feeble the spark, the greater was the decomposition of the carbonic acid found to be. When 100 volumes of dried carbonic acid were brought into one tube, and 150 volumes of a dried mixture of carbonic oxide and oxygen were brought into the other, and a series of sparks were passed through both from the same coil, the volume of carbonic acid increased, and the volume of carbonic oxide and oxygen diminished, until after some hours they became equal. On a further prolonged passage of the spark the two volumes altered together, sometimes increasing and sometimes diminishing, as the nature of the spark varied. A coil of fine platinum wire was heated by an electric current to whiteness in dried carbonic acid. No permanent alteration of volume was produced. When a similar coil of platinum wire was heated in a mixture of dried carbonic oxide and oxygen, it glowed intensely for some minutes, and complete combustion was found to have taken place between the two gases. No flame was visible around the wires.—On the influence of silicon upon the properties of cast iron, by Thomas Turner, Assoc.R.S.M.—Eleven months' experience with toughened glass beakers, by R. J. Friswell.—Bromo-derivatives of diphenyl, tolylphenyl, and ditolyl, by Prof. Carnelley and Andrew Thomson.—Note on the influence of strain upon chemical action, by Prof. Carnelley and James Schlerschmann.—On the non-existence of gaseous nitrous anhydride, by William Ramsay, Ph.D.—On the causes of the decrepitations in samples of so-called explosive pyrites, by B. Blount.—On the specific action of a mixture of sulphuric and nitric acids upon zinc in the production of hydroxyamine, by E. Divers, M.D., F.R.S., and T. Shimidzu, M.E.—On the action of pyrosulphuric acid upon certain metals, by E. Divers, M.D., F.R.S., and T. Shimidzu, M.E.—On the constitution and reactions of liquid nitric peroxides, by E. Divers, M.D., F.R.S., and T. Schmidzu, M.E.—On the behaviour of stannous chloride towards nitric oxide and towards nitric acid, by E. Divers, M.D., F.R.S., and T. Haga.—Preliminary note on the reaction between mercurous nitrate and nitric oxide, and between mercurous nitrate and nitrites, by Edward Divers, M.D., F.R.S., and Tamemasa Haga.—On some derivatives of anthraquinones, by A. G. Perkin and Dr. W. H. Perkin, jun.

**Royal Microscopical Society**, June 10.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Suffolk exhibited a collecting bottle (made by Mr. Stanley) with flat sides, which had been worked to a true surface, through which an ordinary objective could be focussed with perfect definition.—Prof. Stewart called attention to a specimen he exhibited under the microscope, and a model showing the special eyes of Chitonidæ described by Prof. Moseley.—Mr. Wright's letter with reference to Dr. Anthony's criticism on his note on the structure of the tongue of the blow-fly was read, in which he gave all the credit of the discovery of the suctorial organs to Dr. Anthony, whose paper on the subject had been previously unknown to him. He also sent a slide of the blow-fly proboscis, mounted by Mr. Sharp, whose method of preparation and mounting in the biniodide of mercury solution was described.—Mr. Suffolk said he had examined Mr. Wright's first specimen, and he had also made a similar specimen of his own; but the conclusion he came to was that the appearances described were due to some sort of diffractive effect and that they were in fact out-of-focus appearances.—Mr. J. Mayall, jun., called attention to the fact that a Nobert 19-band test-plate had been successfully mounted in Prof. Hamilton Smith's medium, having a refractive index of 2·4, the results being to render the lines very much more visible than had been the case before The preparation was made by Dr. van Heurck, and was attended with considerable difficulty. He now thought it possible to improve upon the photomicrographs of the late Dr. Woodward of Washington, for, the lines being mounted in the highly refractive medium, could be illuminated by immersion means, so that an objective of higher aperture than any employed by Dr. Woodward could be used to resolve them. He hoped to try some experiments in photographing the test-plate by means of Powell and Lealand's new homogeneous immersion, 1/12th of 1·5 N.A.—Mr. Crisp said that they had received from Prof. W. A. Rogers, of Cambridge, U.S.A., a collection of upwards of 60 slides, showing the action of a diamond in ruling lines upon glass. The series was accompanied by a descriptive paper, which, when printed in the *Journal*, would enable the Fellows to compare it with the slides. The President said that Prof. Rogers had expressed the hope that some one might feel sufficiently interested in the subject to make a careful study of the slides. They had not yet had any opportunity either of examining the slides or reading the paper, but their best thanks were due to Prof. Rogers for his valuable donation.—Theiler's "Universal Pocket Microscope" was exhibited by Mr. Crisp.—Dr. Maddox said that since the last meeting he had continued his experiments on the feeding of insects with bacilli, and had fed both the wasp and the blow-fly with the Anthrax bacillus. They had lived on through the month until that very hot day when the thermometer rose to 136° in the sun, when they succumbed to what he believed was heat asphyxia, so that he was unable to attribute their deaths to any effect of the bacilli.—Mr. Waters read his paper on the use of the avicularian mandible in classification, the subject being illustrated by drawings.—Mr. Cheshire described a method of mounting in glycerine, which he had found of great advantage with the particular class of preparations (insect anatomy) with which he had lately been engaged; he further illustrated his meaning by drawings upon the blackboard and by the exhibition of specimens which were handed around for inspection.—Prof. M. N. Dutt's letter was read, accompanying some unknown powdery substance found near Delhi.

SYDNEY

**Linnean Society of New South Wales**, May 27.—Prof. W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—Note on the brain of *Halicore australis*, Owen, by N. de Miklouho-Maclay.—On a new species of *Haloragis* from New South Wales, by Baron F. von Müller, K.C.M.G., &c.—Two new Australian Lucanidæ, by William Macleay, F.L.S., &c.—A list of the *Cucujidæ* of Australia, with notes and descriptions of new species, by A. Sidney Olliff, Assistant-Zoologist, Australian Museum. In this paper, which is a preliminary contribution towards a monograph of the family, fourteen species are added to the Australian fauna. Ten new species are described, including five belonging to the genus *Læmophlœus*. A fine new *Brontes* from Port Darwin and the Richmond River, measuring 14 mm. in length, is characterised under the name of *B. macleayi*. It is distinguished from all the Australian species of the genus by its rather convex elytra, and in having the prothorax with the anterior angles very prominent and the sides feebly serrate. A table showing the geographical distribution of the species is added.—Description

of some new fishes from Port Jackson, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum. Four fishes are here described—a new genus and species of Blenniidæ—*Petraites heptaolus*, also *Platycephalus macrodon*, *Percisnova-cambria*, and *Latris ramsayi*, the latter remarkable in its want of villiform teeth.—Note on *Neoanthias guntheri*, Cast, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum.—Notes on the geology and water supply of the interior of New South Wales, by the Rev. J. Milne Curran, F.G.S. The author points out the conditions under which the plains of the western interior have been formed, explains the river system or drainage of the level country, and indicates the sources of the subterranean waters which are met with in the gravel formations generally known as "drifts."—Some remarks on the fertilisation of the genus *Goodenia*, by E. Haviland.—Notes on a medusa from the tropical Pacific, by R. von Lendenfeld, Ph.D.—Contributions to the zoology of New Guinea; notes on birds from the Astrolabe Range, with descriptions of some new species, by E. P. Ramsay, F.R.S.E., &c. In this paper two new forms of Paradise birds, *Parotia lawesii* and *Lophorina superba minor*, are described, the former differing chiefly from its ally from Mount Arfak in the shape of the frontal crest and olive-coloured shield, the latter chiefly in size; measurements of specimens from both districts are given. The remaining portion of the paper gives a list of species hitherto only recorded from Mount Arfak.—Description of a new species of Collyriocincla, from Queensland, by E. P. Ramsay, F.R.S.E., &c.

PARIS

**Academy of Sciences**, July 13.—M. Bouley, President, in the chair.—A method of determining the absolute co-ordinates of the polar stars without the necessity of ascertaining the instrumental constants (declinations), by M. Lœwy.—Telluric spectra, by M. J. Janssen. The author reports the completion of the apparatus prepared in M. Ducretet's *ateliers* for the study of the gases in the terrestrial atmosphere and of the vapour of water.—Note in reference to M. Stieltjes' communication on a uniform function, by M. Hermite.—On the motion of a heavy revolving body attached by a point of its axis (continued), by M. G. Darboux.—On the theoretic aim of the late M. Henri Tresca's chief studies in the field of mechanics, by M. de Saint-Venant.—A study of the action of dust-particles left to themselves, by M. Chevreult. The particles in question came from a factory in Paris, where the hair of cows and calves is prepared for the spinning-mills of England. They have been left for a twelvemonth on a sheet of red paper in a cylindrical vessel, where they have presented certain mechanical, physical, and chemical phenomena studied and photographed by the author.—Fundamental principles of the new science of dynamic meteorology: reply to M. Mascart's note of June 29 (second part), by M. H. Faye.—Remarks on the same subject in reply to M. Faye, by M. Mascart.—Magnesia; its preparation from sea-water and application to various branches of industry, by M. Th. Schlœsing.—On the central nervous system of *Tethys leporina*, by M. H. de Lacaze-Duthiers.—Note on the homography of two infinitely-extended solids, by M. Sylvester.—On the nature of the transformations undergone by extenuated charbon virus cultivated in compressed oxygen, by M. A. Chauveau.—Remarks on Dr. Brouardel's report on his recent mission to Spain, by M. Pasteur. If Dr. Ferran has really discovered a remedy against cholera he will stand in no need of any Minister's signature; all mankind will welcome a guarantee of the moral and material value of his discovery. To persist in refusing to see this would justify all suspicions, as has become evident since the publication of the replies made to the French Mission in Spain. Dr. Ferran now wishes to withdraw from the position taken up by him, as appears from his fresh note addressed to the Academy. On this issue Dr. Brouardel will be the first to congratulate himself.—Remarks accompanying the presentation of the second edition of his work on the origin of the world, by M. H. Faye.—Protection against cholera by means of hypodermic injections of pure cultivations of the comma bacillus, by M. Jaime Ferran. The Spanish physician describes the results obtained from his method as quite astounding, and maintains that it offers an absolute remedy against cholera. The dangers of attack and death begin to disappear five days after vaccination, and the immunity from further attack increases with each successive injection. The period of immunity cannot yet be accurately determined, but a minimum of two months may already be confidently anticipated.—Observations of Barnard's new comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On a law of reciprocity in the theory of displacement of a solid body, by M. A. Schœnflies.—On a uniform function in mathematical analysis, by M. Hermite.—Observation of a cloud of black particles which were seen to cross the solar disk with varying velocity on August 28, 1871, by M. E. L. Trouvelot.—Indices of refraction for some crystallised alums, by M. Ch. Soret.—On the spectra of absorption of some colouring matters, by MM. Ch. Girard and Pabst.—On the electric resistance of copper at a temperature of 200° C. below zero, and on the isolating point of liquid oxygen and nitrogen, by M. S. Wroblewski.—Heat of formation of the bromide and iodide of antimony, by M. Guntz.—On the double bromides of gold and phosphorus, and on a chlorobromide, by M. L. Lindet.—On a method of producing the alkaline earthy manganites, by M. G. Rousseau.—On the development of the Hematodes, and especially of *Ascaris megalocephala*, by M. de Lacaze-Duthiers.—On *Adamsia pallatia* and its association with *Eupagurus Prideauxi*: a hitherto unrecorded instance of symbiosis, by M. Faurot.—On the parasites of *Mæna vulgaris*, by M. R. Saint-Loup.—First traces of the presence of Permian rocks in Brittany, by M. Ed. Bureau.—On the Permian formations occurring in the departments of Aveyron and Hérault, by M. J. Bergeron.—On the distribution of luminous intensity and visual intensity in the solar spectrum, by M. Aug. Charpentier.—On a case of cebocephaly (atrophy of the nasal process), complicated with partial anencephaly, observed in a foal, by M. Dareste.—Attenuation of the cholera virus, by MM. Nicati and Reitsch. From a series of experiments made on the guinea-pig the authors conclude that the cultivated virus loses all efficacy after a few weeks.—Photographic experiments in a balloon, by M. G. Tissandier. During an ascent on June 19, 1885, in Paris, the author, aided by M. J. Ducom, obtained some excellent photographs at elevations ranging from 605 to 1100 metres. By the new processes of instantaneous photography these operations have been greatly facilitated, and may render effective service in time of war.—Remarks on a partial earthquake felt only on the surface of the ground in the Department du Nord, by M. Virlet d'Aoust.—Note on the microzymas of the Jequirity plant, by MM. J. Béchamp and A. Dujardin.

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